

## Turfgrass Water Use, Irrigation, and Water Conservation



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### Turfgrass Sites and Irrigation Practices

Turfgrass is a valued resource in urban, suburban and rural settings. The large acreage occupied by turfgrass in these areas require home consumers to use water wisely when drought impacts water supplies. Water use for the maintenance of urban plant vegetation may result in a threefold increase in domestic water use during the summer months (Kjelgren et al., 2000). In arid regions of the United States, 40 to 45% of residential water use is applied to the irrigation of urban landscapes (Devitt and Morris, 2010). Due to the home consumers' heavy reliance on the presence of green tissue to determine plant health, irrigation is frequently initiated at the first sign of leaf wilt. The inability to distinguish between drought stress and plant survivability can lead to the misuse of water resources.

Turfgrass is maintained with very low to high maintenance management programs (mowing, fertilizer, watering, etc.) and when healthy its leaves are 80% water by weight. As the soil dries out between rainfall or irrigation events, leaves can discolor and show signs of wilt. This often happens at mid-day but the plants often recover from this condition at night. Eventually irrigation will be needed to restore soil moisture to prevent wilting at mid-day. Wilt is a sign of moisture stress and turfgrasses can rebound quite well when irrigation is applied. Moisture stress becomes more severe on non-irrigated sites, on irrigated sites during imposed stages of water restrictions, or during periods of extended drought after the decision is made to not irrigate.

### Irrigation 101 - The minimum understanding needed to irrigate with good knowledge and practice!

#### **The Soil Beneath The Grass.**

The turfgrass cannot be expected to do all the "heavy lifting" regarding water conservation and surviving periods of drought. The best management practices in growing all plants begin with properly prepared soil of a good quality, depth and fertility for healthy plant growth.

**Use Best Management Practices (BMPs).** First, when establishing a turf, plant the most adapted drought tolerant turfgrass for your location and landscape. Secondly, use best management practices to produce the healthiest turfgrass possible. A turfed area does not need to be "jalapeno green" to be healthy. This includes factors such as basing a fertility program on a soil test report, not over or under applying nitrogen, mowing at the proper height and frequency and applying supplemental water (irrigation) to supplement rainfall when the turfgrass is showing signs of needing water. Raising the mowing heights toward the higher

range recommended for any grass increases tolerance to heat stress. can aid in developing better root systems if the soils has good aeration. Yet higher heights also increase leaf area and somewhat increased water loss.

**How grasses use water.** Water is lost from turf though evaporation from water in its liquid form at the surface of the soil, on turf leaves or in the turf canopy. Transpiration is the process where water is lost from plant leaf surfaces, exiting the plant through tiny openings in the leaves called stomata. As the water evaporates from the leaf surface the plant cools itself. The movement of water from roots to leaves also carries mineral nutrients dissolved in the water to growing points in the plant. Water loss from plants is usually measured by weather stations as potential evapotranspiration (abbreviated as ET). This measurement is in inches. Healthy warm season grasses can persist without moisture stress if only 60% of the weather station reference ET is met through rainfall or irrigation. This is the source of the weekly water requirements listed by city in Table 3. The Texas A&M ET Network (<http://texaset.tamu.edu/>) is available through the internet and reports weather station ET for a number of sites in Texas.

Table 1. Expectations of grass performance or survival with decreasing soil moisture levels.

Declining soil moisture levels and turf condition	Strategy in water use
<b>Excessive</b> - Yellowish discoloration & decreased leaf and root growth, easily damaged/worn by traffic, poor recovery, weakened pest and stress resistance.	Slopes for surface drainage, better drainage away, reduce irrigation duration or frequency.
<b>Optimum</b> - Grass is near maximum health with good best management practices (BMPs), good leaf growth and rooting, easily recovers from injury, good density, tolerates stress, resists pests.	Continue to follow (BMPs), irrigate at recommended amounts each week.
<b>Moderately Dry</b> - Moderate leaf discoloration (leaf firing & turning brown - varies with grass type) Decreased leaf and root growth and function, poor recovery from injury, reduced pest and stress resistance	Apply water to move turf to better health or maintain at this level with less applied irrigation. Grass will survive without going dormant
<b>Dry</b> - More leaf discoloration (leaf firing). Grasses that can will go dormant and shut down leaf and root function. Others without dormancy capability will be severely damaged or die.	Allow grasses that can go dormant to do so.
<b>Exceptionally Dry</b> No Water for plant use (Prolonged Drought). Potential dehydration of growing points and death	Prepare to assess turf recovery after drought ends or irrigation is resumed. Use BMPs to promote recovery.

**Conditions that impact evapotranspiration (ET).** Plant ET, and soil water replacement to keep up with demand is greater with sunny days, high temperatures, higher wind and low relative humidity. More humid conditions in East Texas typically have much lower summer ET rates than areas in West Texas. Cloudy days, low temperatures and high relative humidity and absence of wind slows ET rates.

**When to water based on plant needs?** This typically occurs mid-day (solar noon) when some turf areas begin to show signs of moisture stress and wilt. Yet this is not a good time to irrigate. The best way to proceed is to irrigate during the night to early morning period following observations of wilting. Most grasses respond to moisture stress by taking on a dull purplish cast and the leaf blades begin to roll or fold. Grass under moisture stress also shows evidence of "footprint" tracks after someone walks across the turf. These are the first signs the grass is about to wilt. With some careful observation and experience, it is easier to determine how many days parts of a turf area can go between waterings.

**What time of day to water for greatest efficiency?** Early morning (3 to 8 am) is the best time to water. Wind is usually calm and the temperature is low, so less water is lost to evaporation and there is more uniform distribution across the irrigated area. A disadvantage to watering in late evening is the grass staying moist all night, making it more susceptible to disease under humid conditions. Disease is less of a concern in more arid locations. Evening/night watering does have the benefit of low evaporation rates. Avoid watering during the day as evaporation is greatest and wind disrupts the uniformity of irrigation. The only exception to not watering during the day is in localized areas that are wilting. Lightly watering these "hot" spots by hand may be needed on higher maintenance turf to prevent serious damage.

**How deeply to water - how to get the water into the soil?** When a turf needs to be watered, it is ideal to apply enough so that the soil is wetted to a depth of 4 to 6 inches. If this can be accomplished, then this type of "deep and infrequent" irrigation is best. The type of soil has a great deal to do with how much water is needed to wet soil to the desired depth. Light but frequent irrigation may cause the turf to become weak and shallow-rooted. Shallow rooted turf does not hold its color long in the absence of irrigation, and its leaves will brown off quicker than a turf that has a deep root system. Water infiltration rates vary by soil type and slope of the land. Cycle through shorter but repeated irrigation cycles to best match infiltration on tight soils or sloping terrain.

### **The Challenge - Apply Water In Measured Amounts To Measured Areas!**

- Rain gauges measure rainfall in inches and are highly recommended.
- Recommendations as to how much water to apply in the absence of recent rainfall is usually stated in inches.
- Water provided to consumers by their municipality are charged for water use by gallons used. One-inch of irrigation equals 0.62 gallon of water applied per square foot. This converts to 620 gallons of water for each 1,000 sq ft.
- Irrigation controllers, or hose and sprinklers, are typically set to water zones for a number of minutes.
- Time watered, in minutes, rarely links back to gallons watered and inches applied.

- Therein lies the challenge to watering with “good knowledge and practice”; to understand how to apply water in measured amounts (inches), while accounting for any contribution of measurable rainfall (inches) and being able to relate inches applied to gallons needed at any particular time of year.

**It All Begins With Checking How Much Water Is Applied Over Time.** An irrigation audit is nothing more than a method of measuring how long it takes an irrigation system to deliver an amount of water, measured in inches just like rain gauges measure rainfall. Yet, to be meaningful the measurement should relate back to how long the automatic irrigation system, or the sprinkler at the end of the hose, needs to operate in each zone. To be a good irrigator one needs to be able to measure how many inches of water is delivered per hour. Home consumers can hire a professional licensed irrigator to do the audit, or they can do their own audit. The recommended method is to:

- Place five to eight straight sided open-top cans or cups (cat food cans, tuna cans, etc.) throughout each irrigation zone.
- An alternative is to use the Aggie Catch Cans available from the Texas AgriLife Extension Bookstore (<https://agrilifebookstore.org/>). Item # SP-368 is the Aggie Irrigation Catch Can Set of 12 with ring stands. The Aggie Catch Can is cone-shaped and has graduated markings in both inches and millimeters. Unlike tuna cans, catch volumes may be read directly without the need for rulers.
- Run the irrigation system for preplanned time; 10-minute or 15-minutes is a starting point.
- Then measure the depth of water in each can with a ruler.
- To determine the precipitation rate for each zone, add all measurements from all containers, divide the total number of inches by the total number of containers used, then multiply by six for 10-minutes or by 4 for 15 minutes.
- This will provide the average precipitation rate for each irrigation zone in inches per hour.
- The weekly run time for each zone can then be determined by dividing the weekly turf water requirement by the calculated precipitation rate (in/hr). Irrigation run times for each zone should be short enough that no runoff occurs.

Example:

- Five cans were placed throughout zone one.
- The irrigation system was run for 10 minutes.
- The depth of water in each can was: 0.3, 0.25, 0.25, 0.2 and 0.25 inches respectively.
- The average depth over the five cans is 0.25 inches in 10 minutes, or 1.5 inches per hour.
- If 1 inch is the weekly water recommendation, the irrigation system will need to run for 0.67 hours (1 inch divided by 1.5 inches), or about 40 minutes, throughout the week.
- This can be broken into three, 12-15 minute waterings spaced through the week.

### **Water Savings Summary**

- Run the irrigation system on a set schedule and adjust the runtime incrementally to water just enough to avoid visual signs of turfgrass stress.

- Have your irrigation system checked out for problems such as broken heads, leaking valves, heads not popping up properly, etc. All these problems will result in more water being applied than is actually required.
- Water in early morning hours.
- Use best management practices (fertilization, mowing and aeration) to avoid plant stress conditions.

**Turfgrass Water Use Versus Drought Resistance.** Turfgrass water consumption depends on the range of possible irrigation strategies, which are influenced by clientele expectations, seasonal and annual rainfall, heat, and any need to recover from sports turf type traffic.

In ranking water use, daily water use compares very favorably among warm season turfgrasses when the goal is to produce a healthy turf for the intended use. Periods of drought are common to Texas and irrigation restrictions during drought are not uncommon. How grasses respond to an extended drought varies among Texas Turfgrasses. Warm season grasses reduce their water consumption as soil water is depleted. Table 2 provides the relative level of turfgrass drought tolerance by species, assuming good soil depth and appropriate best management. Shallow soil depths may reduce drought tolerance.

Table 2. Relative resistance of turfgrasses to drought.

Grass Species	Level of drought resistance	Comments
Buffalograss	High	Very good dormancy mechanism with excellent recovery potential from drought induced dormancy. Adapted to areas receiving less than 25 inches of rainfall or irrigation per year. Has a lower water use rate (ET) than other warm season grasses. Survived 60-days of summer drought in San Antonio on a deep soil profile
Bermudagrass	Very good - High	Good dormancy mechanism with very good recovery potential from drought induced dormancy. Survived 60-days of summer drought in San Antonio on a deep soil profile.
Zoysiagrass	Very Good - High	Zoysia japonica varieties (El Toro, Empire, Jamur, Palisades) and Zoysia matrella varieties (Emerald, Cavalier, Zeon and Zorro) show very good dormancy-type mechanisms and have survived 60-days of summer drought in San Antonio on a deep soil profile. Moderate to slow drought recovery capability.
St. Augustinegrass	Moderate to Good	Moderate drought resistance due to an extensive, deep root system in deep soils. Poor dormancy mechanisms. Variety dependent. High tolerance to dehydration. St. Augustinegrass varieties survived 60-days of summer drought in San Antonio on a deep soil profile. Significant turfgrass loss during prolonged drought periods .

## Turf Sites In The Real World - Irrigated or Not

**Seasonal Influence** - The water requirement is reduced during the late fall to late winter. This reduced need is also reflected in the seasonal water requirements in Table 3. Warm season grass spring regrowth requires night time temperatures to be consistently above 60 degrees F. For winter and spring seasons where normal rainfall occurs, mild stress is tolerable. Irrigation is often not even necessary until late spring/early summer due to stored soil water.

**Unirrigated Turf** - Requires good soil infrastructure and drought resistant grasses. Lower turf quality is expected with seasonal drought or rainfall deficits. Turf used during periodic moisture stress or drought is unable to tolerate/recover from normal traffic.

**Irrigated Turf - Without Good Knowledge and Practice** - Not able to irrigate in measured amounts (inches of applied irrigation). Results may include unhealthy turf, runoff/wasted water, not able to conserve, greater costs, greater water consumption. Little appreciation for soil infrastructure needed to support healthy plant growth and rooting. Often poor soil quality and shallow soils require more frequent irrigation to maintain any standards of quality.

**Conservation opportunity:** Consumer behavior makes it difficult for communities to conserve water and they then move to provide incentives to reduce the size of turf areas and move to alternate landscape planting perceived to be more efficient in consumptive water use.

**Irrigated Turf - With Good Knowledge and Practice To Good Soil Infrastructure** - Golf course, high quality sports fields or well managed commercial lawns are good examples of this category. Turf professionals irrigate in measured amounts (inches of effective irrigation) to measured areas. The hot spots that might appear between irrigations, within irrigation zones can be individually hand irrigated and used as indicator areas of when to next irrigate. Irrigation systems have high industry standards for design, operation and maintenance. They are operated to obtain the greatest uniformity of water distribution (best is 70 to 80%) by irrigating at best time of day, eliminating over application and runoff, matching water precipitation rates to on-site variables that include soil infiltration rates and slopes.

**Conservation opportunity:** Can do good things as far as water conservation as the landscape is healthier and treated as a whole unit.

### **Irrigated Turf - With Good Knowledge and Practice To Poor Soil Infrastructure**

Soils are a major impediment to uniform water infiltration, percolation, and retention. Sites may be challenging as far as poor soil quality, shallow depth, three-dimensional uniformity and diminished water holding capacity. The results are highly irregular turf quality across properties unless watered frequently enough to mask poor soil infrastructure. There is greater likelihood of multiple hot spots between irrigations if the site is allowed to dry too much. Management to maintain quality requires frequent irrigation and results in greater potential for water runoff.

**Conservation opportunity:** Remediate or improve the poor soil conditions to better manage water to be better able to conserve water. Adjust irrigation rates and cycling to match soil infiltration rates. If not addressed, this consumer behavior makes it difficult for communities to conserve water and they then move to provide incentives to reduce the size of turf areas and

move to alternate landscape plantings perceived to be more efficient in consumptive water use.

## How Much Water Is Enough For Turf In Midland Texas

Table 3. Approximate weekly water requirements (replacement by rainfall or irrigation) for Midland Texas to maintain warm season turf “Without Stress” (WS) or a turf that will persist under “Moderate Tolerable Stress” (MTS) for conserving water and/or savings on water bills during periods of drought. Table assumes maximum irrigation system distribution uniformity. Adapted from historical evapotranspiration data (<http://texaset.tamu.edu/pet.php>)

City	Irrigation Program	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		-----Water Need (inches absorbed by the soil) Per Week-----											
Midland	WS	0	0.1	0.2	0.9	1.1	1.2	1.4	1.3	1	0.3	0.1	0
Midland	MTS	0	0	0.1	0.5	0.6	0.7	0.8	0.8	0.6	0.2	0	0

**Weekly Water Requirement for Warm Season Grasses - Midland, Texas.** This “stair-step” type approach by month varies and provides a “target” water amount as rainfall or irrigation. This is true if the desire is to water for what can be a relatively healthy turf (WS) or if the goal is to use less water for conservation and/or savings on irrigation expense (MTS). Both levels assume maximum irrigation system distribution uniformity. Of course the ability to irrigate may be impacted by drought related water restrictions. During times of water restrictions, moving to the Moderate Tolerable Stress level of irrigation is more realistic, in line with societal concerns over water resources and able to maintain the turfgrass stand throughout drought. Water restrictions are discussed in the next section. *Note: turf used for sports fields will require water above WS level to recover from the additional stress of traffic and wear that is normal with such use.*

## Watering practices based upon watering restrictions

**Without water restriction - no drought:** typically conservation efforts are maintained year-round. This would place a time restriction on the hours one could irrigate. One commonly used is “watering allowed before 10 am or after 8 pm every day. This 14-hour window takes advantage of those times of the day when wind, sunlight, temperatures are at their lowest levels and allow for the best water distribution, least evaporation and greater chance for the maximum absorption (infiltration) of water into the soil.

**Things to know...** Without restrictions, home consumers should irrigate to supplement natural rainfall. If irrigation is needed watch the weather forecasts for upcoming chances of rain and schedule irrigation accordingly. Maintain a deep infrequent irrigation schedule. This approach is best for the overall health of the turf, regardless of the water status. It reduces potential for turf disease, helps insure good air movement down to the root system, and conserves water.

During the designated times, apply enough water to adequately wet the soil to a depth of 6 inches..

*Note: The following water restrictions are modeled after the San Antonio Water System (<http://www.saws.org/conservation/aquifermgmt/index.shtml>) and are but one example of the types of water restrictions that may occur.*

**A Stage 1-type restriction:** Typically the time allotted for irrigation remains the same, 14 hours (before 10 am or after 8 pm), but the number of days irrigation is allowed is reduced. Irrigation is only allowed once per week based upon the last digits of your street address.

**Things to know...**The same approach can be used as in times without watering restrictions. If the soil is thoroughly wet to a depth of 6 inches with each watering cycle, the turf should be able to go a week between irrigation cycles. If necessary, use a hand-held hose to water those areas that show drought stress symptoms before the next allotted irrigation date. Monitor to make sure irrigation has reached the appropriate soil depth. Continue mowing as needed. Reduce your fertility program, keeping nitrogen levels low. Use a shower or fan type nozzle on your hose to help evenly disperse the water.

**A Stage 2-type restriction:** Once per week watering remains. Further efforts at conservation are achieved by further limiting the amount of time allowed to water on that one day each week. Hours when irrigation is allowed might be from 3 to 8 am and from 8 to 10 pm, a total of 7 hours per day.

**Things to know...**By reducing the time allocated for irrigation, larger home landscapes or commercial properties may not have enough allotted time to irrigate the number of irrigation zones on the property. When spray, rotor or impact nozzles are configured to water the turf, drip systems may be in place to water the landscape plantings in the ornamental mulched beds. Limiting the time available to water to 7 hours results in evaluating how to be able to irrigate all zones in a limited time frame.

**A Stage 3-type restriction:** Watering on a once every two week schedule is initiated. Typically the time allotted for irrigation remains the same, 7 hours (from 3 to 10 am and from 8 to 10 pm).

**Things to know...**Irrigation during Stage III becomes more difficult as you can water only once every two weeks. Continue following a deep irrigation program to help maintain a healthy root system. Consider adopting one of the following approaches during Stage III water rationing.

1. Water only areas that are showing severe drought stress with a hose. Make sure that enough water is applied to effectively wet the soil. When puddling or run-off begins, stop watering that particular area, let the surface dry and then resume watering. Continue this cycle until the soil is wet to the appropriate depth. Use a sharp spade to help determine the depth of water penetration. Those areas should not be watered again until severe moisture stress

symptoms again appear. This will be a time intensive approach, requiring daily attention. Time and size of the turf area will determine whether it is a viable option.

2. If time and patience are a limitation, or the turf area is too large, you may want to stop watering the turf all together. Before using this approach, there are a few things to consider. Most warm-season turfgrass species have the ability to survive short periods of drought stress. When grass is under severe drought stress, it may go dormant. Dormant grass will be brown and may appear dead. Once watering or rain begins again, grasses will recover, assuming the drought has not been too severe. Recovery will be slow and may take up to three months during the growing season. Grasses that are able to go dormant during drought are buffalograss, *Zoysia japonica*, and bermudagrass. Other species do not possess this type of drought resistance mechanism. Significant turfgrass loss can occur if these species are allowed to experience severe drought stress for an extended period of time. If the grass possesses a strong dormancy mechanism, consider eliminating irrigation. However, if your grass does not have a strong dormancy mechanism, and is allowed to experience long periods of drought stress, a significant amount of turf may be injured and need to be replaced.

3. Water only high priority turf areas and allow other areas to go dormant or die. High priority areas are determined by each individuals specific needs and preferences. If the back yard is utilized more than the front, it would be the high priority area. If an aesthetically pleasing landscape is important, then portions of the front yard might be the priority. This approach will allow the home consumer to maintain green turfgrass only in important areas of the yard, saving water and time. Suspend mowing without significant growth and keep traffic off the area. Eliminate fertilizer applications at this time. Use a shower or fan type nozzle on your hose to help disperse the water when hand watering.

**A Stage 4-type restriction:** Further restrictions may be imposed in response to even a greater need to conserve water beyond what is achieved with lesser restriction stages. All outdoor water usage is prohibited.

**Things to know...** This stage is quite easy – do not water the turf. Buffalograss, bermudagrass and some of the zoysiagrass varieties will probably survive under no irrigation. Grass survival will depend upon the length and severity of drought. Grasses eventually go into a dormant state until the drought stress is eliminated, at which time it will become evident if they will recover. With moderate periods of drought and good soil depth, survival rates should be high for these three species. St. Augustinegrass, seashore paspalum, centipedegrass, tall fescue and some other grass species may be severely injured or die if exposed to extended periods of drought. Dead areas may be seeded, sodded, plugged or sprigged after drought conditions end. The best method of re-establishment will be determined by the species and variety of turfgrass. Suspend mowing without significant growth and keep traffic off the area. Stop any fertility program, until drought restrictions are lifted.

**Summary.** Turfgrass is an important resource in our communities. Responsible use of water for turfgrass irrigation should be front and center in the minds of those maintaining fine turf as home and commercial lawns, sports fields, parks and golf courses. Water has always been a

limited resource in the State of Texas, and in times of drought, the water supply can become so depleted that cities are required to initiate water restrictions. Water conservation will certainly continue to be a part of our lives as the Texas population grows. Those who irrigate

should be pro-active in learning to apply irrigation in measured amounts, based upon seasonal need and Texas location. It is also important to recognize that well managed warm season turfgrasses are quite resilient to periods of moisture stress without the risk of severe injury.

References:

Devitt, D., and R. Morris. 2010. Sustainable water use in urban landscapes in the 21st century: A Las Vegas perspective. *Acta Hort.* (ISHS) 881:483–486.

Irrigation Technology Center, TexasETNetwork. 2011. Texas Average ETo. Available at <http://texaset.tamu.edu/pet.php> (verified June 22, 2011)

Kjelgren, R., L. Rupp, and D. Kilgren. 2000. Water conservation in urban landscapes. *HortScience* 35(6):1037–1040.

San Antonio Water System. 2011. Drought Restrictions. at <http://www.saws.org/conservation/aquifermgmt/index.shtml> (verified June 22, 2011)

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