PROACTIVE WATER USE FOR SPORTS TURF MANAGEMENT

IMPLICATIONS OF MUNICIPAL WATER RESTRICTIONS • PROCEEDINGS PUBLISHED IN SUMMER 2006 SPORTS TURF MANAGER

WORKSHOP SESSIONS IN ORDER OF APRIL 6 SCHEDULE

- *The Ontario Low Water Response (OLWR)*, George Sousa, Grand River Conservation Authority
- *Watering Restrictions and the Need to Conserve*, Steve Gombos, Water Efficiency Manager, Region of Waterloo
- *Managing Functional Athletic Turf*, Tim Ernst, Former Supervisor of Sports Turf, City of Kitchener
- *Water in the Bank*, Terry Gillespie, University of Guelph
- *Get Smart: You Cannot Manage What You Cannot Measure*, Gregory Snaith, EnviroIrrigation Engineering Inc.
- *Workshop Summary*, Rob Witherspoon, Director, Guelph Turfgrass Institute

During the past several years, an increasing number of municipalities have implemented water use restrictions for turf for all purposes. These restrictions have become a serious concern for those responsible for premium field conditions for many sports such as soccer, football and baseball. On April 6, 2006, the Sports Turf Association hosted a workshop, the intent of which was to bring together those involved in managing the water supply of a municipality in the best interest of its citizens and those responsible for the management of quality sports turf surfaces for use by its citizens. In order to further distribute the wealth of information presented, we are pleased to publish summary articles provided by our speakers. We extend our thanks to them for further participating in this project.

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ONTARIO LOW WATER RESPONSE (OLWR)

A MEASURE INTRODUCED IN RESPONSE TO LOW PRECIPITATION IN THE PROVINCE DURING THE LATE 1990s

Many communities in southern Ontario are faced with water shortages because of a growing population and a limited supply of good quality drinking water. This has led to placing a high value on water and conservative water use. In addition to limited sources of water, there can be further reduction in supply due to natural conditions such as low rainfall and hot temperatures. Ontario Low Water Response (OLWR) was introduced in response to low precipitation in the late 1990s which caused drought conditions throughout many parts of Ontario. It is a voluntary program designed to take early action during low water conditions to minimize socioeconomic and ecological impacts caused by low water availability.

It is important to understand that water restrictions can be put in place for many different reasons. A water supply system may have a short term loss of volume caused by equipment failure, contamination or accident. In these instances, water restrictions may be initiated to preserve the supply capacity for essential water use. These restrictions are often temporary and may last a few days to a few years depending on the supply problem.

Water restrictions may also be placed on a community seasonally to help control spikes in water use and keep the cost of additional water supply infrastructure to a minimum. Finally, water restrictions can be put in place in times of drought when water availability is low because of low flow in streams and rivers or low ground water tables. It is in this last case when OLWR is initiated.

Low Water Conditions and Drought

To understand OLWR it is important to understand the terms low water conditions and drought. During the course of a typical year there will be times when the amount of precipitation may not be enough to offset the need for water. This is part of the natural yearly cycle and should be taken into consideration when designing water supply systems.

Low water conditions happen when precipitation is lower than normal leading to low flow in rivers and streams and possibly affecting the groundwater table. Low water conditions can occur as the result of a few weeks with no precipitation during a dry period or one year of extremely low precipitation or a few consecutive years of lower than average annual precipitation. Long term low precipitation can stress the natural system to the point that it may take several years of higher than average precipitation to recover. Drought is an extreme case of low water availability.

An example of annual precipitation over 65 years at Lake Belwood's Shand Dam on the Grand River is shown in Figure 1. Average annual precipitation is set at zero, with positive values representing higher than average precipitation years and negative values representing lower than average precipitation years. Examples of extreme low precipitation years such as 1963 and 1998 and consecutive years of low precipitation such as the early 1960s and late 1980s can be seen.

Ontario Low Water Response (OLWR)

OLWR was designed to deal with low water and drought conditions caused by natural factors. The program relies on stakeholders to voluntary reduce water use through conservation efforts when faced with low water conditions. Only in extreme drought conditions will regulated water restrictions be imposed by the province, although municipalities may impose water restrictions for their serviced areas as part of a voluntary water use reduction plan.

Since OLWR is based on voluntary reduction in water use, one of the most important aspects of the program is its cooperative approach to decision making. Decisions regarding the request to reduce water use are made by the local Water Response Team (WRT). The WRT is made up of representatives from local industry, municipalities, commercial and special interest groups. In this way, each stakeholder group can voice their concerns regarding water use and help to share the burden of conservation efforts. The degree of low water in the watershed is expressed by the OLWR using a system of Levels shown in Table 1.

The decision to declare a Level I or II low water condition lies with the local WRT. Level III can only be declared by a provincial committee with recommendation from the local WRT. The WRT meets to discuss low water levels when one or both of the indicators for that level are reached (see Table 2). They will declare a low water level if they feel the situation will not improve unless water use is decreased (e.g. no forecasted precipitation). Once a level is declared, it is the responsibility of the WRT with help from provincial representatives to communicate the request to reduce water use in their area.

During the course of a typical year there will be times when the amount of precipitation may not be enough to offset the need for water. This is part of the natural yearly cycle and should be taken into consideration when designing water supply systems.

The Grand River and OLWR

The Grand River watershed has had an active WRT since 2001. The team meets regularly to review low water conditions, share between members, and discuss water conservation efforts. Membership in the Grand WRT includes representation from each of the member municipalities, agriculture, golf course superintendents, aggregate producers, fish and wildlife special interest groups, First Nations and the Conservation Authority. Many provincial and federal representatives sit on the committee as advisory members without voting rights. The Grand River Conservation Authority (GRCA) provides technical support to the committee. During low water conditions, the WRT meets as needed to declare or remove levels.

The Grand WRT has used various methods to reach voluntary reductions during Level I and Level II conditions. They include issuing press releases to the local media encouraging water conservation, contacting large water users in the watershed directly, and meeting with sector groups to formulate plans for water conservation. Voluntary water reduction strategies that water users in the watershed have used include municipal outdoor water use restrictions, water recycling and recirculation, installing water storage systems, and staggering water takings. Voluntary water use reductions within the Grand River watershed have helped during low water conditions to prevent socioeconomic and ecological losses as the result of low water flows.

To provide information regarding low water conditions to the general public, the GRCA maintains a section on their website for low water response. In this section, current conditions are posted for various areas of concern within the watershed. Information includes daily flow rates, 7 day average flow rates, and indicators for each level. Current precipitation values can also be found on the GRCA website.

Observations

Although the Grand WRT has had success with using OLWR to help mitigate low water conditions, OLWR is not the solution to water shortages. The program was designed to deal with infrequent water shortages caused by low precipitation and to act quickly when faced with low water conditions to attempt to avoid socioeconomic and ecological losses. The solution to water shortages lies in proactive planning and resiliency in both the water supply system and with the end user. For the sports turf industry, building resiliency into turf surfaces is essential. This may include new varieties of turf, more innovative and adaptable irrigation systems, and better understanding of soil-water-plant interactions. Drought conditions, although infrequent, are unavoidable. Building resiliency into water supply and water use systems and planning for low water availability can lessen the impact of drought conditions allowing for faster recovery from drought and reducing economic losses.

Figure 1. Annual precipitation at Lake Belwood's Shand Dam on the Grand River from 1940 to 2005. Annual precipitation is measured as the difference from the long term average over the given time period.

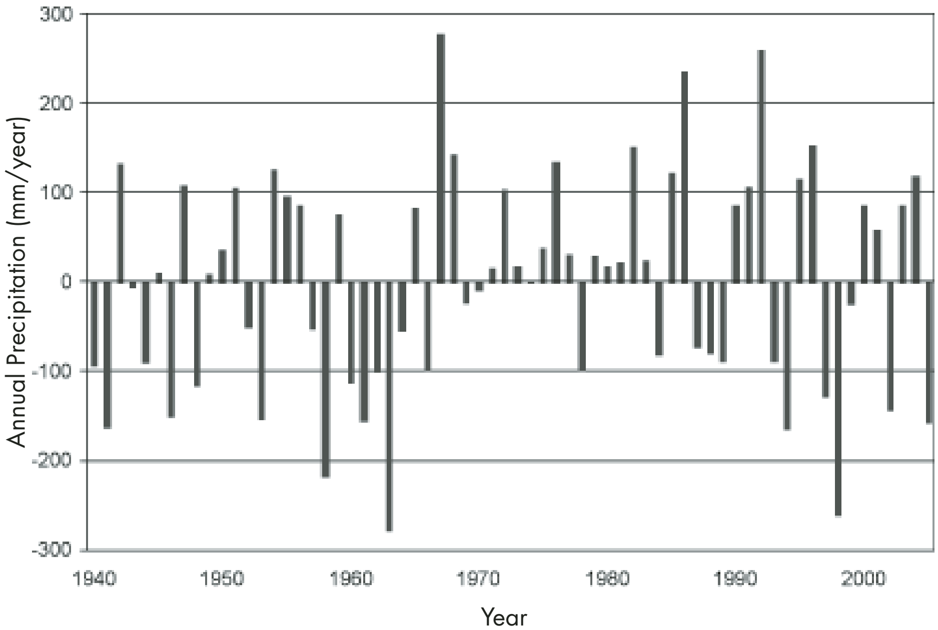


Table 1. Description of each level under OLWR and what action should be taken if the level is declared.

Level	Description	Action
Level I	Potential water supply problem	Voluntary reduction of water use by 10%
Level II	Potentially serious water supply problem	Voluntary reduction of water use by 20%
Level III	Failure of the water supply to meet demand	Possible regulation of water restrictions by provincial agencies

Table 2. Indicators for low water conditions under OLWR (adapted from OLWR MNR July 2003).

Condition	Indicator	
	Precipitation	Streamflows
Level I	<80% of 3 or 18-month average	<70% of normal summer low flow
Level II	<60% of 1, 3 or 18-month average	<50% of normal summer low flow
Level III	<40% of 1, 3 or 18-month average	<30% of normal summer low flow

For More Information

- www.grandriver.ca – Low water conditions and declared levels for the Grand River Conservation Authority
- www.mnr.gov.on.ca – Low water conditions for the province, OLWR regulations and information
- Or contact your local conservation authority or MNR district office ♦

~ Presented by George Sousa, P.Eng., Manager of Resource Science, Information and Policy, Grand River Conservation Authority. Written by Stephanie Shifflett, EIT, Water Resources Engineer, Grand River Conservation Authority

WATERING RESTRICTIONS AND THE NEED TO CONSERVE

PEAK DEMANDS ARE MAINLY ATTRIBUTABLE TO OUTDOOR WATER USE, PRIMARILY LAWN WATERING

In 2005 the Region of Waterloo implemented "Stage 2" outdoor water use restrictions due to the temporary loss of wells supplying the Greenbrook Pumping Station. The water restrictions were in effect from May 15 to September 30, 2005. Lawn watering was restricted to the hours of 7:00 a.m. to 10:00 a.m. and 7:00 p.m. to 11:00 p.m. one day per week. The date was dictated by the last digit in the street address, beginning with 0 or 1 on Monday and progressing to 8 or 9 on Friday. No weekend irrigation of residential lawns was allowed.

In Ontario there is a myth that we have plenty of water. While bountiful, there are increasing demands on the Great Lakes water and pipelines to tap them are expensive. Due to ecological impacts there has been a decline in ground water levels and the demand on ground water continues to rise. Recurring drought has taxed the recharge of these aquifers. Then there are the risks of contamination of existing sources, which was the cause of the Greenbrook and Walkerton problems.

The Region of Waterloo has 80 active water supply wells and one Grand River intake. Eighty percent of the region's water supply comes from these wells while 20 percent is derived from surface water. The long term plan is a pipe line to Lake Erie but current scheduling has that set at 2035. The region's current supply system is facing numerous problems such as aging wells with declining output, rapid residential and industrial growth and more stringent provincial regulations while at the same time having to maintain a minimum reserve for fire protection and other emergencies.

One role of the Water Services Division of the Region of Waterloo is to provide potable water at wholesale costs for local utilities that sell to residential, industrial, commercial and institutional customers. The average daily demand for these purposes in the region is 36 million gallons per day; however, peak demands during the summer months can reach 52 million gallons per day. With a maximum pumping capacity of just over 50 million gallons per day in Waterloo Region, the need for conservation during peak times is apparent. These peak demands are mainly attributable to outdoor water use, primarily lawn watering.

To minimize the peaks in water demand, the region undertook several initiatives to reduce outdoor water consumption. Among these were an educational program about water conservation, rainwater harvesting and Stage 2 water restrictions. Stage 2 restrictions were intended to limit discretionary outdoor use but not to limit business usage.

A recent survey revealed that 91 percent of respondents support outdoor water use restrictions. During the summer of 2005, peak water demand was reduced by at least 10 percent per capita compared to 2001 and 2002, which were similar years for temperature and precipitation levels.

To accommodate the concerns of the managers of municipal sports fields, the restrictions on water use at Stage 2 have been lifted for the 2006 season. The reason for this amendment to the region's bylaw was it considered sports fields as highly specialized surfaces with strict requirements for seeding, management and efficient irrigation practices. It was also noted that sports fields are operated as a business, and a decline in turf quality may result in lost business. ♦

~ Presented by Steve Gombos, Water Efficiency Manager, Region of Waterloo
Summarized by Bob Sheard, Sports Turf Association

MANAGING FUNCTIONAL ATHLETIC FIELDS

WATER RESTRICTIONS MAKE IT INCREASINGLY DIFFICULT FOR SPORTS TURF MANAGERS TO PROVIDE ACCEPTABLE FIELDS

Functional: not necessarily aesthetic nor pleasing, but serving a purpose.

Safe: free of danger or risk (for athletes)

Durable: resists wear (weather and competition)

Enhance: heighten or intensify (the game)

The responsibilities of sports turf managers go well beyond maintaining and managing healthy turfgrasses. Field performance plays a major role in determining whether playing conditions enhance the game as well as providing a safe playing surface. Over the last several years, restrictions have been placed on the use of pesticides and also water in some areas. This causes me great concern, that as sports turf managers, we are finding it increasingly more difficult to provide acceptable playing fields for varying levels of play.

An issue I would like to address is the use of terms such as *aesthetic purposes*, *non-essential*, *cosmetic* and *lawngrasses*. These are descriptions often used to define limitations on the use of pesticides or water. Unfortunately to date, sports turf is typically combined with lawngrasses and general parkland when it comes to language surrounding restrictions. It is fairly obvious to sports turf managers that athletic fields are not lawngrasses, but functional turfgrass areas designed specifically to host and support athletic events.

I choose to categorize turfgrasses into three areas. They are 1) utility turf: medians, erosion control, etc.; 2) lawngrasses: residential and commercial properties, general parkland; and 3) athletic turf: a) golf turf, b) sports turf.

As mentioned above, the sports turf manager must be aware of much more than cultivating healthy turfgrasses. It is my opinion that we should be providing "safe, durable athletic fields that enhance and support the game." This article will focus mainly on the role of water and how it relates to field performance.

Can we use these definitions when describing our fields? As the level or intensity of competition increases, so does the demand on the athletic surface to perform – or allow athletes to perform safely and to the best of their ability. I break down performance of an athletic field into three areas: 1) impact absorption; 2) traction, footing and stability; and 3) enhancing the game.

Athletic Turf, Soils, Moisture and Related Performance

In order to provide safe fields and in turn improve field performance, we must first be able to successfully maintain a healthy turfgrass community. The three simple or basic needs that the plant requires are light, nitrogen and **water**. Without any, or all, it is absolute – the turf community will fail. Why is it imperative that we provide a healthy stand of turfgrass? What does the turfgrass provide for athletes?

Turfgrass Density

It is the turfgrass density of the field, or the individual number of plants per square unit of measure, that greatly enhances the impact absorption capabilities and reduces abrasiveness of the surface. Impact testing equipment such as the Clegg Hammer measures deceleration of the internal hammer dropping, which in turn measures surface hardness (GMAXX). Through research, we know that GMAXX ratings upwards of 200 pose greater risks for athletes (Consumer Safety Authority). Not only acute injuries, but medical information also points to chronic injuries due to exposure to poor surfaces. This exposure weakens tissues and can lead to muscle and sprain injuries. Dense turfgrass provides a cushion for athletes. Interestingly enough, as high school fields face maintenance challenges, I was approached by regional athletic directors at area high schools seeking advice for concerns they had over witnessing increases in shoulder, ankle and concussion injuries suffered by their varsity athletes.

The density of the field also plays a major role in providing an athlete with traction (linear and rotational), footing and stability. This can be referred to as the torque characteristics of a playing surface. Stops and starts and changes in direction are all part of sport. Poor footing exposes athletes to a greater risk of tears and sprains.

Note: 1). Not only general density, but individual turfgrass varieties exhibit different shear strength ratings under the same cultural inputs. National Turfgrass Evaluation Program trials (NTEP) provide a good starting point for selection of premium athletic turf varieties. 2). At times of high heat, fields high in *Poa Annua* content can be syringed to reduce stress and maintain density during summer

Soils and Soil Moisture

Soils and soil moisture play an important role on impact absorption and traction/footing, etc. Coupled with turfgrass density, the moisture content and soil texture determine the ultimate impact rating of a field. The higher the moisture content and the lighter the soil texture, the "softer" the field will play. Take football for example. The argumentative object of the game is to put your opponent on the ground as quickly and aggressively as possible. Why do elite football players prefer to play on natural surfaces versus artificial, especially earlier generation synthetic turfs? A lack of resiliency in the playing surface significantly increases the risk of impact injuries.

Field construction specifications are gradually improving in Canada, with more "engineered soil" fields being constructed, but many existing and new fields are native soil based with high clay content. As soil moisture is depleted on these fields, surfaces begin to harden. Depending on the level of play, ET based irrigation practices may sustain healthy turfgrass, but may at times leave the immediate playing surface firmer than one would like. Lighter textured rootzones provide more favourable impact characteristics under depleting soil moisture, but must be managed much more carefully due to water holding capacity characteristics.

Quick Tip. Sub-surface irrigation operated by a gate valve with rapid speed turf rotors will provide water to the skin without the cost of labour involved with hand watering.

Enhancing the Game

Ultimately, field performance, as it relates to turf, is influenced by cultural practices, turfgrass density, rootzone composition and soil moisture. Field performance will determine how the playing surface enhances or supports the game. I mentioned previously how turf density impacts footing and traction for safety purposes. I also mentioned that fields that look great may not perform very well. Remember, we're managing functional athletic turf, not lawngrasses or general parkland.

Cultural practices such as mowing (frequency, quality and height of cut), overseeding (frequency and species/varietal selection), thatch levels, topdressing (frequency and material selection), fertility and irrigation practices (overall turfgrass health/density and soil moisture) etc. all greatly influence every athletic event. The ability of the playing surface to support stops and starts and changes in direction determine the stability or torque strength of a field.

Obviously, elite athletes require greater stability from the field than youth recreational athletes. The speed, weight and forces generated by athletes at higher levels of play create these demands. The skill, precision and speed of the game is greatly affected by poor playing conditions (hence the NFL tarping policy). I spoke with George Toma, retired NFL groundskeeper and now charged with installing the playing surfaces for the Superbowls, for over an hour specifically on how he advises on the size and number of cleats to wear in relation to torque characteristics of the field. (A modified torque wrench fitted with cleats provides readings).

Turfgrass rooting, rootzone composition and topdress applications factor in determining field stability. Sand provides much greater friction for a playing surface, especially under wet conditions, than does heavier soils (1/4" - 1/2" of thatch may provide a soil buffer and increase footing). The flipside can be that heavier soils will provide more root stability than sands. Tear out and divoting are sometimes an issue, more often on sand based systems, but native soils too high in upper profile water content are prone to divoting and lack of stability as well. Although organics may be beneficial in increasing water/nutrient holding capacity and "loosening" tight soils, layering of these materials by continual application of high organic matter topdress blends can adversely affect the stability of the root system. Establishing athletic fields on the Holland Marshes would produce less than desirable playing surfaces. Furthermore, excessive organic matter may reduce percolation rates or cause water repellency in sand based systems.

Ball response is also influenced significantly by how sports turf managers manage the playing surface. Field sports such as baseball (will discuss infield skins later), soccer and field hockey all rely on surface uniformity and consistency, as a large portion of the game is played with the ball rolling across the playing surface. An example would be how high mow heights and/or surface non-uniformity lead to soccer players taking a completely different approach to the game. It becomes played more through the air versus along the ground. This not only impacts the quality of game for elite athletes, but also influences how our youth are trained and learn the game. It affects how the ball is fielded, passed or dribbled over the surface. Safety implications also exist by the way of unexpected ball responses leading to ball strikes, especially in baseball.

Infield Skin Management

Unfortunately, the importance that water plays in managing baseball infields is not often realized in Canada. As with culturing turfgrass, looks can be completely misleading as to the performance and safety of the surface. Although somewhat off topic, I feel it necessary to quickly brief readers on infield management techniques before discussing the **important role water plays**. The four key areas I like to focus on when managing baseball infields are: 1) selection of material; 2) conditioning products; 3) moisture management; and 4) surface preparation.

A baseball infield must perform in a similar fashion as turfgrass. The field manager must be concerned with impact absorption, traction, footing, stability and also how the skinned surface will enhance or support the intended level of play. All four of the above criteria combine to determine infield performance. Although this is not a discussion specifically on cultural practices for managing athletic fields, it does need to be mentioned that the demands of the intended user require different approaches to design and management.

Ascertaining the intended level of play, selection of material and implementation of a management program is key for an infield to perform well. The capability to apply correct amounts of water and the infield to absorb and hold these amounts becomes more critical as the level of play increases. The information below leans towards managing infields for elite play.

Selection of Material

The type or composition of the infield blend will factor heavily in the success of the field. The typical "stone dust" infield would certainly not enhance or may even in fact create safety concerns for higher levels of play, while a more favourable infield blend or "professional" type blend may be excessive for lower levels of play. Very briefly, an infield blend or product should not be overly abrasive for lower levels of play and have the ability to provide a "tight" surface, hold adequate moisture and exhibit drainage characteristics for higher levels. The infield blend I like to use and have had success with consists of 60% sand, 25% clay and the rest silt screened to 1/8".

Conditioning Products

The use of specifically designed products that condition infields greatly improve the quality of the playing surface, absorb excess water and also reduce the amount of water required to manage an infield for elite play. Calcined clay products are my choice due the stability of the product over time. Industrial absorbents do not provide the same characteristics and will break down gumming up your infield skin.

I'd like to mention two types of calcined clay. First, drying agents, which are used to absorb excess water from the field during play and secondly, infield conditioners, which greatly improve the workability of the surface and provide water absorption characteristics as well. The latter is important as the conditioner will release stored water into the infield skin as it begins drying out. Conditioners are incorporated into the skin and infields and then "capped" or topdressed with about a 1/4" of infield conditioner to "seal" in the sub-base moisture and provide an optimum surface.

Moisture Management

Managing the moisture content of the infield skin on a day-to-day basis would be what I consider the most difficult, yet strategic task for providing a top notch playing surface. In this paragraph, I discuss practices for the highest levels of play that I have encountered from major league facilities and national teams down to our oldest age groups for inter-city all-star programs. Moisture content of the infield skin is what provides a resilient playing surface, yet binds the blend together to provide stability. Watering an infield is somewhat similar to irrigating turfgrass – evaporation from the infield skin is proportional to heat, sunlight, humidity and wind. When preparing an infield, the amount of water we use on calm, overcast days with temperatures around 18ºC is much less than 32ºC windy, sunny days. The real trick is to moisten the sub-base (infield soil from 1/2" to 4") and keep it consistently at this level (you'll have to "read" your own infield). This is what enables the field to perform well. Light surface watering is simply to moisten the conditioner and help seal in sub-base moisture.

Surface Preparation

The concept is simple – spike drag and cocoa mat to finish. In my opinion, this process actually has little to do with how the field plays or performs. To truly provide an optimum surface, the critical inputs are material selection, use of conditioners and moisture management. No matter how well the surface is prepared, without fulfilling these criteria, the infield will not perform to the highest standard. Timing is however, very important. When spike dragging, finding that optimum time when the field is dry enough for spiking, but before it begins to set up is key. This allows proper scarification of the top 1/4". Drag matting provides the finished playing surface.

Infield Performance

Managing infields – how does this relate to impact absorption, traction, footing, stability and enhancement of the game? **Water is the key resource when it comes to the performance of an infield**. An infield may be designed properly utilizing a quality blend, infield conditioners incorporated, topdressed on the skin, and the surface properly spike dragged and matted. But without water, the infield will still not provide a safe surface for athletes to perform or enhance the game.

Penn State research identifies infields with 5% moisture content as having a GMAXX in excess of 300 (remember, over 200 is considered high injury potential). Infields with 23% moisture (a properly watered field) had readings of 140. We reduce by half the surface resiliency by the proper application of water. As discussed previously, excessively firm playing surfaces leave athletes at a higher risk for both acute and chronic injuries as the forces are returned to the athlete as opposed to absorption by the field. Furthermore, the majority of baseball injuries are generated by ball strikes. Improperly managed infields can lead to a serious risk from inconsistent ball bounces at high speeds. At top levels of play, the ball can be fielded at speeds exceeding 80 miles per hour. I have witnessed some serious facial injuries due to an unexpected bounce of the ball. Water provides the consistency in ball response that allows fielders to become comfortable and confident and enables them to play the ball much more aggressively.

Footing, stability and traction affect an athlete's performance in the same fashion as turfgrass does in conjunction with field sports. The "tightness" of the infield enables both runners and fielders to stop, start, change direction, plant and make throws. An infield with little moisture not only plays hard, but becomes brittle, unstable and may "blow out" when force is applied by an athlete.

Conclusion

We, as sports turf managers, know the important role water plays in athletic field management programs. In contrast to ornamental turf areas, **water plays a very vital and functional role in providing safe, durable athletic fields that enhance the games of our intended users**. There are many more variables in managing athletic fields than simply maintaining healthy turfgrass. I feel it is our responsibility as sports turf managers to improve field performance and increase awareness to all involved while striving to minimize the injury risks associated with athletic competition. It is also our responsibility to use all available research and resources to minimize the mismanagement of water at our facilities.

I'd like to leave everyone with a final thought: I've never seen an injured golfer carried off the course, or chronically injured, due to poor playing conditions. ♦

~ Tim Ernst, Former Supervisor of Sports Turf, City of Kitchener

WATER IN THE BANK

TREATING SOIL MOISTURE LIKE MONEY IN THE BANK CAN PROVIDE A SIMPLE TOOL FOR IRRIGATION MANAGEMENT

Water in the soil can be treated in the same way that money is managed in a bank account. This simple approach can be used to guide your daily decisions on irrigation, or to provide a rational basis for setting longer-term policies regarding water restrictions during periods of water shortage.

In this approach, the deposits to the soil water account are made by precipitation or irrigation. Therefore, it's necessary to know the amount of precipitation that falls and to calibrate your irrigation system so that amounts of water applied per hour are well known. Withdrawals from the water bank account are caused by evapotranspiration, runoff or drainage below the root zone. Just like our bank account, we'd like to minimize these withdrawals as much as possible (Figure 1).

We want to keep a satisfactory balance in the soil water bank so that the turf growing on this soil is not suffering from unhealthy water stress.

Figure 2. Relationship of clay content to water content of soil.

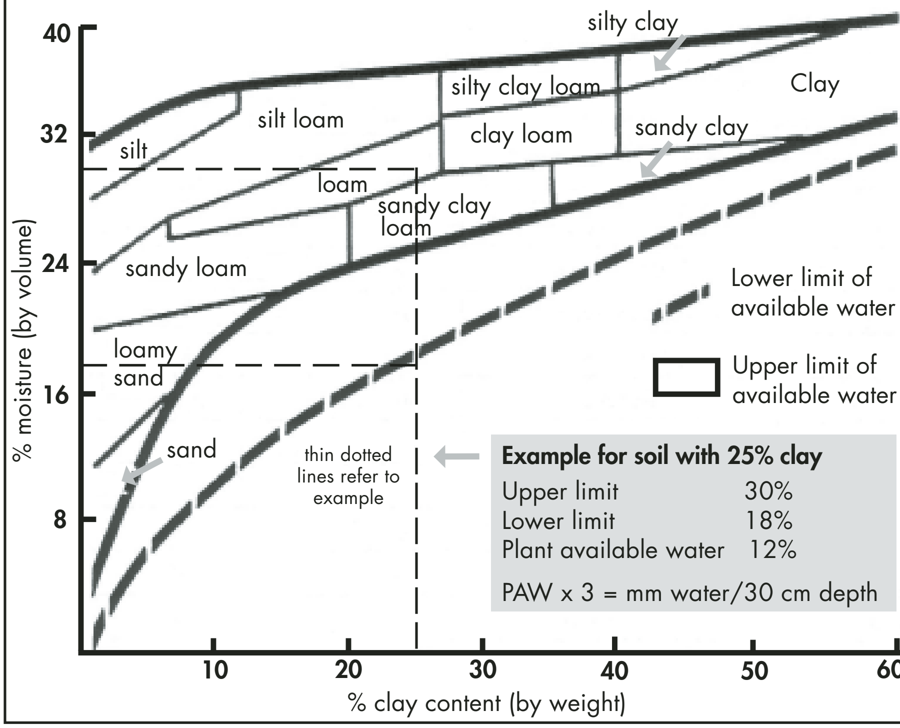
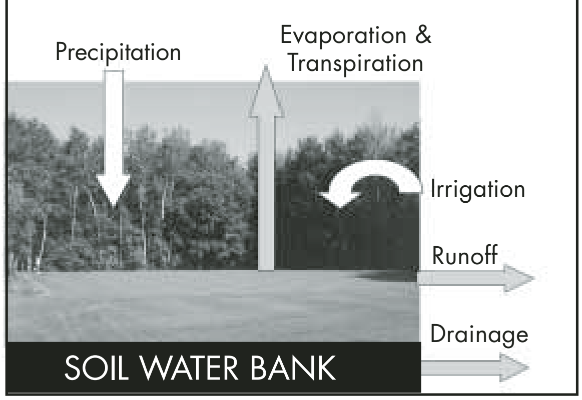


Fig 1. Water in the Soil Bank = Precipitation + Irrigation – Evapotranspiration - Runoff - Deep Drainage



How do we decide what is a "satisfactory balance" of water in the soil? First, the texture of the soil must be determined by sampling and submission to a soil testing laboratory or by consulting a soils map. Each soil type has an upper limit to its water-holding capability when all the soil pores are full. There is also a lower limit to the availability of soil water to plants – when the moisture content is low enough that the water is held very tightly in the smallest soil pores and roots cannot extract it. The difference between the water content at the soil's upper limit and the content at its lower limit of availability to roots is the *plant available water* or PAW. Typically, light sandy soils would have 20-25 mm of available water per foot of root zone, while the PAW for loams would be 40-45 mm per foot and 25-30 mm per foot for clays. Note that clays can have the greatest total soil moisture, but they don't have the biggest PAW because they keep much of this water in their very small pores, out of reach to plant roots. To estimate the upper and lower limits of PAW, it is necessary to know the clay percentage in the soil on your sports field (see Figure 2).

The second thing to decide is what fraction of the PAW can be used up before the turf begins to suffer stress. Experience suggests that it is best to keep the available water above the 50% mark. After a little practice with this idea and your own observations of turf behaviour, you might adjust this percentage to satisfy your own needs.

Let's illustrate these ideas with an example. We'll choose a light soil with a PAW of 24 mm per foot of rooting and assume a 1-foot rooting zone. We'll assume that we have 17 mm in the bank on Day 1, which means the account is 71% full (17/24 x 100 = 71%). On Day 2 there is warm, sunny, dry weather causing a withdrawal of 5.5 mm due to evapotranspiration from the turf and soil. An estimate of daily ET can be obtained from Table 1 and Table 2, from an on-site weather station that measures temperature, humidity, sunshine and wind; or from private companies that provide such information for turf management. Table 1 uses visual observations of four weather factors – sun, temperature, wind and humid-

ity to give an estimate of pan evaporation (tech speak for evaporation from a water surface). Pan evaporation is adjusted to turf evapotranspiration by multiplying by a correction factor for plant species and time of the year (Table 2).

These data can be entered into a spreadsheet (Table 3). We can see that the percent available water at the end of Day 2 is only 48%. Taking the guideline mentioned earlier, that turf will start to suffer stress when the soil available water drops below 50%. Thus, we need to irrigate on

Table 2. Correction factors for adjusting pan evaporation to grass ET.

Month	Correction Factor
April	0.45
May	0.55
June	0.65
July	0.75
August	0.75
September	0.55
October	0.45

Table 1. Estimators for pan evaporation based on observed weather conditions.

	One pm weather observations for:			Estimated Pan Evaporation (mm)
Sunshine	Temperature (C)	Humidity *	Wind**	
Full	Greater than 23	Low	High	8.0
Full	Greater than 23	Low	Low	7.5
Full	Greater than 23	High	High	7.0
Full	Greater than 23	High	Low	6.5
Full	Less than 23	Low	High	6.5
Full	Less than 23	Low	Low	6.0
Full	Less than 23	High	High	5.5
Full	Less than 23	High	Low	5.0
Cloudy	Greater than 23	Low	High	5.0
Cloudy	Greater than 23	Low	Low	4.5
Cloudy	Greater than 23	High	High	4.0
Cloudy	Greater than 23	High	Low	3.5
Cloudy	Less than 23	Low	High	3.5
Cloudy	Less than 23	Low	Low	3.0
Cloudy	Less than 23	High	High	2.5
Cloudy	Less than 23	High	Low	2.0

* Low = clear sky, unlimited visibility; High = smog, haze, fog
** Low = leaves and small branches moving; High = tree tops moving

Tables 1 & 2 reproduced from *Understanding Turf Management*, R.W. Sheard, 2005

Day 3. Knowing that the weather forecast is suggesting some light rain on Day 4, we cleverly apply only 12 mm (about 1/2 inch) of irrigation water. This partly refills the soil water bank to 73% and leaves some room to store the coming rain. About 6 mm of ET also occurs on this warm, sunny, windy day (Table 4). On Day 4 we receive 10 mm of rain and lose only 1.8 mm of ET due to cool, cloudy and windy conditions.

Why did 1.7 mm of runoff occur on Day 4? At the end of Day 3, we had 17.5 mm in the soil water bank. On Day 4, we had a 10 mm rain deposit and a 1.8 mm ET withdrawal, for a net income of 8.2 mm. Therefore our bank balance should be 17.5 + 8.2 = 25.7 mm. But our soil has an upper water holding limit of just 24 mm, so 25.7 - 24 = 1.7 mm must run off, and the soil bank is left 100% full at the end of Day 4.

The loss of 1.7 mm of rain to runoff can be used to illustrate an important point. If we had irrigated to completely refill the soil reservoir on Day 3, we would have lost much more of the natural rainfall to runoff. Therefore the practice of replacing yesterday's ET by irrigating every day will not make best use of natural rainfall. In an experiment on a simulated golf green at the Guelph Turfgrass Institute, we found daily irrigation to replace ET used about 25% more water over the growing season than irrigation when the available soil water bank became 50% empty.

To finish a week on the spreadsheet (Table 5), Day 5 is cool and sunny (ET = 3.5 mm); Day 6 is cloudy and humid (ET = 2.5 mm); then hot, sunny, windy and humid weather arrives on Day 7 (ET = 5.0 mm).

Now we find that we are approaching 50% available water in the bank again and need to be planning another deposit by irrigation. Even though our week's weather has contained some rain and some cloudy or cool days, turf on this soil could not remain stress-free if regulations permitted, for example, only weekly irrigation. When we run similar simulations for loam soils (recall that loams have the highest available water capacity of all soil types), we often still cannot keep them stress-free with only weekly irrigation in the summer.

In summary, treating soil moisture like money in the bank can provide a simple tool for daily irrigation management and a simple way of providing rational advice to policy makers who are dealing with water regulations. Such analyses suggest that daily irrigation to replace yesterday's evapotranspiration is not the most efficient water management procedure. This keeps the soil water reservoir too full and causes unnecessary losses of natural rainfall by runoff or drainage.

On the other hand, it is often not possible to keep turf fields in top quality, stress-free shape when irrigation is restricted to weekly intervals during the summer. There is a "happy medium" somewhere between these two limits. Turf managers can apply the principles of water budgeting described in this article to utilize an allotment of water in the most efficient way. This approach, rather than the imposition of a fixed time interval between allowed irrigation events, could have a positive impact on sports turf health during the summer season. ♦

~ Prof. Terry Gillespie, Department of Land Resource Science, University of Guelph

Table 3. Example Spreadsheet.

Day	Rain	Irrigation	ET	Available Water	Percent Available	Runoff or Drainage
1				17 mm	71%	
2	0	0	5.5 mm	11.5 mm	48%	0

Table 4. Example Spreadsheet Continued.

Day	Rain	Irrigation	ET	Available Water	Percent Available	Runoff or Drainage
2	0	0	5.5 mm	11.5 mm	48%	0
3	0	12 mm	6.0 mm	17.5 mm	73%	0
4	10	0	1.8 mm	24 mm	100%	1.7 mm

Table 5. Example Spreadsheet Continued.

Day	Rain	Irrigation	ET	Available Water	Percent Available	Runoff or Drainage
4	10	0	1.8 mm	24 mm	100%	1.7 mm
5	0	0	3.5 mm	20.5 mm	85%	0
6	0	0	2.5 mm	18 mm	75%	0
7	0	0	5.0 mm	13 mm	54%	0


McNally Street Park Soccer Field


Centennial Park Soccer Field

ENVIROIRRIGATION

YOU CANNOT MANAGE WHAT YOU CANNOT MEASURE

MANY IN THE INDUSTRY HAVE ENDORSED THE SWAT™ CONCEPT AS THE STANDARD WATER CONSERVATION METHOD

The *Irrigation Water Efficiency Pilot Study* was commenced in July, 2005 to evaluate a weather based computer controlled irrigation system by utilizing a SWAT™ technology controller - Smart Water Application Technologies™. An Irrigation System Assessment and Irrigation Water Efficiency Assessment were completed to determine the operational performance, identify any deficiencies and calculate onsite water usage of existing irrigation systems. Data collected included monthly water meter readings, irrigation schedules, daily evapotranspiration rates (ET), turf conditions and soil moisture.

Two irrigated sports fields within the City of Guelph were chosen for the study, Centennial Park soccer field and Hastings Stadium baseball diamond. Centennial Park soccer field was upgraded by replacing the existing conventional irrigation controller with a SWAT™ technology controller.

Two irrigated sports fields within the Town of Halton Hills were also chosen for the study, McNally Street Park soccer field and Berton Blvd. Park soccer field. McNally Street Park soccer field was upgraded by replacing the existing conventional irrigation controller with a SWAT™ technology controller.

SWAT™ technology automatically adjusts controller run times throughout the season. These controllers relied on local weather stations to automatically calculate the need for irrigation based on daily and weekly evapotranspiration (ET) rates required by the sports field turf.

In order to compare SWAT™ technology to the previous conventional controller, conventional fields were designated the reference fields. For example, Berton's irrigation schedule was superimposed onto McNally Street Park to simulate the comparison of SWAT™ technology to a conventional controller. The Berton controller remained under the management of park staff and field notes were recorded to log changes in irrigation schedules. Using this method of comparison, McNally Street Park would have watered 43% more using the Berton Blvd. Park conventional controller schedule.

Summary

Although the adoption of SWAT™ technology has been slow, much of the irrigation industry has endorsed the concept as the standard method by which to conserve water. But technology itself without measurement will not be enough in order to calculate the rate of return. As a wise irrigation specialist once said: "You cannot manage what you cannot measure."

SWAT™ technology automatically adjusts controller run times throughout the season.

Acknowledgements

My sincere appreciation and thanks to Rakesh Mistry from the Town of Halton Hills and Ian Haras from the City of Guelph for their cooperation and vision to participate in a project that is on the forefront of what is soon to become common place irrigation technology. ♦

~ Gregory Snaith, P.Eng., President, EnviroIrrigation Engineering Inc.

WATER WORKSHOP SUMMARY

WATER RESTRICTIONS HAVE BECOME THE NORM IN MANY CANADIAN MUNICIPALITIES

Four key issues were presented at the workshop: 1) water use regulations and the rationale for water conservation; 2) the role of water in sports turf management; 3) effective irrigation; and 4) importance of good fields to the end user.

Water use restrictions have become the norm in many Canadian municipalities. Southern Ontario has a growing urban population that has a significant water demand. Peak water use demand occurs during summer months and is attributable primarily to landscape irrigation although car washing and filling swimming pools also contribute to demand.

Climate change may lead to more regular periods of reduced water availability. Drought conditions both increase seasonal water taking and decrease surface water flow in streams and rivers which are used as the indicator to initiate water use restrictions through the Ontario Low Water Response mechanism. Municipal water systems also face the challenge of designing and maintaining systems that are capable of handling short term, peak seasonal water demands. Any disruption to the system, such as contamination and shutdown of well fields as has happened in Waterloo Region, further reduce system capacity to deliver water.

Water use is critical for maintaining functional athletic turf. Dry, dormant turf does not have the recuperative potential, playability or cooling effect of actively growing turf. User groups clearly favour fields that are irrigated over non-irrigated fields. Most municipalities with field classification systems would typically rank their irrigated fields within the top level of classification. Turf managers are becoming more attuned to effective water management both through common sense use of the resource to optimize turf growth as well as though the use of current irrigation technology which provides a high degree of control over water application.

Where regulation and professional sports field management fail to meet is in the development of policy that takes into account effective field irrigation. There is a range of approaches to water restrictions but most are based on time and day of the week restrictions such as odd and even date watering corresponding to the municipal address of properties as well as limited time frames during the day when irrigation may be applied. These approaches are easy to communicate to homeowners and enforce, but they do not take into account the needs of sports fields which are significantly different from home lawns. A more effective approach for sports fields may be to budget water use to a level sufficient for growth but permit longer periods of application which may be needed depending upon the capability of the irrigation system to deliver the appropriate amount of water.

Where do we go from here? A show of hands at the conclusion of the workshop indicated that only two people in the room felt that they had an effective say in water use policy making. It is incumbent on professional sports field managers to both use water responsibly as well as actively communicate the importance of water in an environmentally sustainable turf management system. Golf courses have responded to water restrictions by increasing water storage capacity through pond construction as well as investigating alternative water sources. Most new housing developments require the construction of storm water ponds which could perhaps be integrated with sports field areas to provide an alternative source of irrigation water. In addition to producing potable water, municipalities also treat a significant quantity of effluent water. Although it would require significant infrastructure investment, integrating sports fields into municipal water treatment systems is worthy of further investigation and research.

It is not easy finding a place on the crowded agenda of municipal councils. Development of sports field water use policy that serves field needs as well as municipal demands to reduce water use is a challenge for sports field managers. Utilizing best management practices, staying current with regards to technology and cultural management techniques, investigating alternative water sources as well as communicating effectively with user groups and policy makers are all key in developing a water conservation strategy that will promote safe and functional sports fields. ♦

~ Rob Witherspoon, Director, Guelph Turfgrass Institute