2nd WATER WORKSHOP

Proactive Water Management for *Sports Turf Managers*

Following the success of our inaugeral Spring 2006 workshop, the Sports Turf Association hosted a second *Proactive Water Management for Sports Turf Managers* full day event on March 29, 2007. This workshop addressed the implementation of water use bans and restrictions and the resulting concern for those responsible for premium field conditions for many sports such as soccer, football and baseball. It brought 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. Sessions were organized beginning with a more generalized view of the water management issue progressing to more specific, practical topics for use by turf managers. The following summary articles have been provided by our speakers and we extend our thanks to them for their further participation.

WORKSHOP SUMMARY

ROB WITHERSPOON, DIRECTOR, GUELPH TURFGRASS INSTITUTE

The key issues that poured out of the water management workshop were the increasingly complex regulatory environment surrounding irrigation water use, the need for improving water use efficiencies and the development of best management practices for irrigation system management.

Not a single participant at the workshop was working in a municipality that does not have some form of water use bylaw. A challenge facing sports turf managers is making the various forms of bylaws work for a sports field environment. A system that allows professional field managers to make application timing decisions within a restricted water use situation would make best use of a limited resource. Rather than applying water based on some arbitrary calendar and/or street address criteria, water should be applied in a manner that is appropriate for turf growing conditions. Many managers feel it would be better to have a fixed allocation of water each year to be applied as needed rather than working within a day of the week and/or street address system that is effective for communicating with homeowners, but not particularly suited to the grass plant's needs.

As water restrictions increase, there appears to be a movement towards looking at alternatives to irrigating with treated municipal water. Some properties lend themselves to the construction of on-site irrigation ponds that may provide more flexibility with regards to water use. Capturing on-site runoff is one thing, but if plans call for tapping into an existing stream as a water source, extensive regulations apply including the need to develop a bypass pond and maintain a minimum stream flow. Although not discussed in detail at the workshop, waste water recycling systems that incorporate sports fields may be worthy of future investigation.

Efficiencies in water application are critical for sports turf managers to make best use of this critical resource. Regular auditing of system performance, knowing soil conditions and using some form of water budgeting all contribute to ensuring that water is being applied in an effective and logical fashion.

The general consensus of workshop participants was that water restrictions are an inevitable component of managing sports turf in the 21st century. The key to success is being an efficient water user and communicating with policy makers to ensure that water use restrictions conform with best management practices for water conservation in field management. ♦

What's Inside

WORKSHOP SESSIONS

The Protection of Our Water Resources: A Conservation Authority Perspective
Bob Edmondson, Director, Watershed Management Services, Conservation Halton

Water Efficiency in Halton Region
Wayne Galliher, Water/Wastewater Outreach Coordinator, Halton Region

Establishing a Water Use Baseline
Gregory Snaith, President, EnviroIrrigation Engineering, Inc.

Use It or Lose It: Best Management Practices for Water Management on Sports Fields
Pam Charbonneau, Turfgrass Specialist, OMAFRA

THE PROTECTION OF OUR WATER RESOURCES

A CONSERVATION AUTHORITY PERSPECTIVE BY BOB EDMONDSON, DIRECTOR, WATERSHED MANAGEMENT SERVICES, CONSERVATION HALTON

Conservation authorities, particularly in the Greater Toronto Area, are known to most people for the conservation areas and large tracts of lands that they own and manage for outdoor recreation and education programs. In reality, the formation of conservation authorities came about with the passing of the *Conservation Authorities Act* in 1946 in response to concern expressed by agricultural, naturalist and sportsmen's groups *"that all the renewable natural resources of the province were in an unhealthy state."* The passing of the Act provided the means by which the province and municipalities could join together to form a conservation authority within a specified area – the watershed – to undertake programs for natural resource management. A conservation authority is basically a community-based agency formed on a watershed basis in partnership with its municipalities and the province to deal with resource management issues that cross municipal boundaries.

Hurricane Hazel, 1954

Many of the earlier conservation authorities were formed to deal with resource management issues such as large reforestation initiatives within their watersheds. Most, however, came into being following Hurricane Hazel which found its way into the Province of Ontario in October 1954 resulting in significant loss of life and property damage, particularly within the Humber watershed in Toronto. Approximately 81 deaths were attributed to Hurricane Hazel and some 4,000 people left homeless. The damage was put at approximately $1 billion in today's dollars. The significance of Hurricane Hazel is that it is the storm event that is used in today's standards in dealing with floodplain issues and the protection of life and property.

Hurricane Hazel served as an added initiative for municipalities to join and request the province to form a conservation authority as they were looked at as the ideal agency to deal with flood management on a watershed basis. Today there are 36 conservation authorities across Ontario.

Each conservation authority that was formed prepared a *Conservation Report* on the state of their watershed(s) that looked at flood management issues, the health of the watershed, opportunities for reforestation, recreation and land acquisition. In fact, most of the large tracts of land that are owned by conservation authorities today were originally identified from these early reports that were done in the 1950s and 1960s. These early reports also looked at opportunities to protect life and property through flood management schemes that controlled flooding and erosion. This entailed the identification of sites for reservoirs to control flood flows and channelization projects to divert flows from susceptible areas or control erosion. As a result, significant investment was made in this type of structural approach to flood management that took place throughout the 1960s and 1970s. Examples in the Conservation Halton watershed include the construction of the Kelso, Hilton Falls and Scotch Block dams and reservoirs on the Sixteen Mile Creek and the Mountsberg dam and reservoir on the Bronte Creek. Diversion channels were built in Oakville and Burlington to alleviate flooding in core areas of these centres. A channelization project in Milton was built to control the flows from the Sixteen Mile Creek and alleviate erosion through the downtown core.

Flood Damage Reduction Program

Later in the 1970s a regulatory approach was taken to deal with development within floodplains. Regulations were enacted by conservation authorities through the *Conservation Authorities Act* dealing with construction within floodplains, alteration of watercourses and the filling of valley systems and wetlands. Regional storm events were used as the regulatory storm event, which in the case of most of Southern Ontario is the Hurricane Hazel event that occurred over the Humber Watershed in 1954. In the early 1980s the federal and provincial governments sponsored the *Flood Damage Reduction Program*, which involved the mapping and delineation of floodplains by

conservation authorities based on the regulatory storm. In effect, the intensity and duration of that storm event is transposed over a watershed to determine the extent of flooding that would occur in that watershed during that storm event. Development is prohibited or discouraged from taking place within that flood line. This approach by the province, in restricting development within the floodplain has been borne out in comparisons between significant storm events in Ontario and other jurisdictions. A well documented study comparing flooding in Ontario and Michigan found that although Michigan sustained extensive damage and suffered loss of life, Ontario had, during that same time period, higher flood yields. Even though Ontario's yields were higher the province recorded a small fraction of Michigan's damages. The difference in damages was estimated to be approximately $500,000 in Ontario compared to $310,000,000 in Michigan.

Controlling Development

The Province of Ontario through the *Provincial Policy Statement* identifies the importance of restricting development within floodplains and hazardous lands through Part 3 of the policy statement dealing with Natural Hazards. Conservation authorities represent the provincial interest in matters of natural hazards at the local or municipal level in dealing with development applications.

A conservation authority's regulation for flood plains and fill-regulated areas (e.g. valley lands and wetlands) also deals with the control of pollution and conservation of land as they may be affected by development. Conservation of land within the context of a conservation authority regulation includes preserving the ecological integrity of, for example, a valley system.

Changes to the *Conservation Authorities Act* in 1999 resulted in the development of a *Generic Regulation* to be used by all conservation authorities to ensure more consistency among their individual regulations. In May 2004, the Province of Ontario enacted *Ontario Regulation 97/04* entitled, "Development, Interference with Wetlands & Alterations to Shorelines and Watercourses Regulation." This provides for the regulation of all watercourses, either permanent or intermittent, floodplains and meander belts (of watercourses), erosion hazards, shorelines, wetlands and associated lands and other hazardous lands (e.g. areas of karst topography). Conservation authorities had two years to bring their individual regulations into conformity with the Generic Regulation, which each conservation authority in the province has done as of May 2006.

Changes to the Act and the implementation of the *Generic Regulation* and the associated individual conservation authority regulations have essentially placed all natural hazards as identified in the *Provincial Policy Statement* under the regulations of a conservation authority. Development taking place within an area regulated by a conservation authority requires permission from that conservation authority. Violations of the regulation can result in fines of up to $10,000 or three months in prison. Further, judgments can result in significant restoration costs.

A watercourse does not have to contain fish in it to be considered fish habitat or have permanent standing water. An intermittent watercourse that does not have fish in it yet contributes a food supply to fish is considered fish habitat.

The regulations, in addition to protecting against natural hazards, also allow for the protection of watercourses, valley lands and wetlands. Coupled with this are watershed studies undertaken by conservation authorities to identify restoration initiatives and opportunities to protect and enhance watercourses, valley lands, wetlands and other natural heritage features and to look at strategies for natural heritage systems that should be protected for the long term.

Protecting Fish Habitat

Conservation authorities have also formed partnerships with other agencies for the protection of natural features and habitats. This includes the signing of Memorandums of Understanding with municipalities to provide expert advice on development applications as they may affect natural heritage systems and the signing of agreements with the Department of Fisheries and Oceans to protect fish habitat. Conservation authorities take an active role with their municipal partners in developing subwatershed studies and implementing recommended strategies as lands are urbanized.

The *Federal Fisheries Act* has become much more prominent in the last number of years in protecting fish habitat that may be affected by development. It should be noted that the Act is not new as it was first passed in 1868. Most conservation authorities have formed partnerships through agreements with the Department of Fisheries and Oceans to screen development applications for impacts to fish habitat with the guiding principle of no net loss to fish habitat. What is important to understand is the definition for fish habitat within the *Federal Fisheries Act:*

"*Spawning grounds and nursery, rearing, food supply, migration and other areas on which fish depend directly or indirectly in order to carry out their life processes.*"

A watercourse does not have to contain fish in it to be considered fish habitat or have permanent standing water. An intermittent watercourse that does not have fish in it yet contributes a food supply to fish is considered fish habitat. Section 35 (1) of the *Federal Fisheries Act* prohibits the harmful alteration, disruption or destruction of fish habitat (HADD) without authorization by the Department of Fisheries and Oceans. Contravention of Section 35 (1) may result in a fine of $1,000,000 and three years in prison.

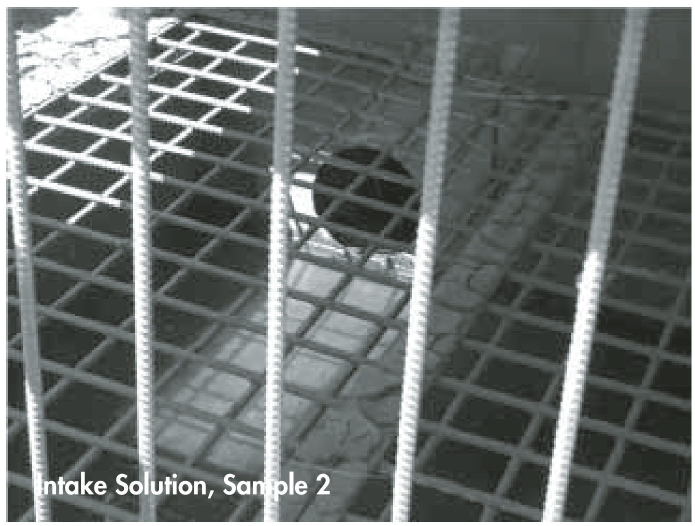
Low Water Response Teams

Most conservation authorities have developed well-rounded programs over the years in caring for the health of their watersheds through restoration initiatives; acquisition of significant natural heritage areas; provision of open space recreational opportunities; stewardship initiatives with private landowners; providing assistance programs to landowners; establishing environmental monitoring programs; key messaging to the public on environmental

Flood Control Then

Flood Control Now

Intake Solution, Sample 1



Intake Solution, Sample 2

matters; advocating for environmental initiatives and implementing specific programs to address the needs of their watersheds.

An example of specific watershed programs includes the development of local *Low Water Response Teams* by most conservation authorities to deal with drought conditions within their watersheds. The programs were developed from measures undertaken by the province in the late 1990s in response to low precipitation. The programs are basically voluntary in nature to initiate actions to address low water conditions in streams or rivers and groundwater tables. The programs use indicators of precipitation and streamflow measured against normal averages. Three different levels of conditions are considered reflecting prolonged periods with little or no precipitation and corresponding reductions in streamflows. Initial actions include voluntary reductions in water use with the most extreme level (Level III) potentially resulting in regulation of water restrictions by provincial agencies. The typical *Low Water Response Teams* that are formed include representatives from municipalities, provincial agencies, the agricultural community, sportsmen associations, golf courses, aggregate operators and the water bottling industry. The teams will meet to review low water conditions; communication action plans to landowners and water conservation recommendations.

Source Protection Initiatives

The contamination of the water supply in the Town of Walkerton in 2000 has led to the province looking at protecting drinking water supplies at its source. Conservation authorities have been identified as playing a key role in the development of source protection plans to protect municipal drinking water supplies. Technical teams have been formed in watershed regions to gather data and information in characterizing the watersheds for the preparation of source water protection plans. The information gathered from existing studies and through new studies has helped all conservation authorities gain a better understanding of the dynamics of their watersheds and the impacts of water taking on surface and groundwater supplies. Shortly, *Source Water Protection Committees* will be formed for each watershed region to prepare assessment reports for their watersheds and ultimately source water protection plans to ensure the long-term protection of drinking water supplies.

Minimizing Sediment Loading

A continuing problem in protecting water resources has been attempting to control sediment loading to watercourses particularly from construction and development activities. Section 36 (1) of the *Federal Fisheries Act* states that *"no person shall deposit or permit the deposit of a deleterious substance into water frequented by fish."* The release of sediment to a watercourse is considered a deleterious substance by the Department of Fisheries and Oceans and there have been well documented cases of substantial fines levied for violation of the Act relating to the release of sediment particularly resulting from construction activities.

Excess sediment can have impacts on fish through abrasion of their gill membranes and suffocating of their eggs. Sediment can also carry toxins, bacteria and excess nutrients and can result in the depletion of oxygen within a water body. Physically, excess sediment can affect flooding, fill in wetlands and influence the geomorphic stability of a watercourse channel.

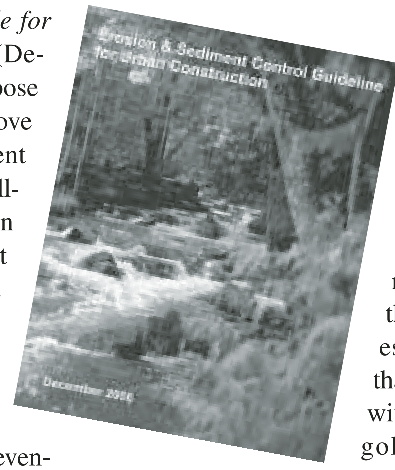
Fish are typically stressed where total suspended solids (TSS) exceed levels of 200 mg/L for prolonged periods. Studies on construction sites in Piedmont, Vermont show the benefits of having erosion and sediment control practices in place in relation to concentrations of sediment:

Pre-construction (background level):	25 mg/L
Post construction:	50 mg/L
Erosion & Sediment Controls:	283 mg/L
Erosion Controls Only:	680 mg/L
No Erosion or Sediment Controls:	4145 mg/L

Studies undertaken more recently in the Toronto area have shown similar results.

Typical factors contributing to problems on construction sites relate to lack of phasing during clearing and grading; long lags between soil disturbance and stabilization; unnecessary clearing of sensitive areas such as riparian buffers, steep slopes and wetlands; inadequate maintenance of sediment controls; poor field inspection practices and enforcement of erosion and sediment control plans.

Erosion and Sediment Control Plans are typically required by conservation authorities through approvals associated with their regulations or by municipalities as conditions of development through the planning process. Recently the conservation authorities within the Greater Toronto Area have produced an *Erosion and Sediment Control Guide for Urban Construction* (December 2006). The purpose of the guide is to improve the practice of sediment control, ensure that a well-defined process is in place and ensure that Erosion and Sediment Control plans are prepared, implemented and enforced. The guide stresses the importance of erosion prevention. It is intended for contractors, consultants, developers/owners, government agencies and government inspectors. Current erosion and sediment control practices and methods are illustrated. More information on the document and up-to-date information on sediment and erosion control is at www.sustainabletechnologies.ca.



Water Takings

A Permit to Take Water (PTTW) is required from the Ministry of the Environment where the taking of water from a surface or groundwater source exceeds 50,000 litres per day (10,000 gallons). In recent years, the Ministry of the Environment has initiated new water conservation requirements for permits to take water. A new classification system has been introduced that places takings in categories as to their potential for causing adverse environmental impacts. There is a greater emphasis on maintaining data on the taking of water on a daily basis and requirements for monitoring and reporting on an annual basis. Water takings in high use watersheds can be refused. Conservation authorities have always been concerned with the taking of water within their watersheds and the cumulative impacts that can affect the aquatic environment. While the Ministry of the Environment through their PTTW controls the actual taking of water, conservation authorities can influence the water takings through their regulatory control on the structures that are required to facilitate the water taking.

In some watersheds, strategies have been developed that set thresholds below which water cannot be taken. In permitting the intake structures, the conservation authority can establish the setting of the intake to ensure that water is not taken during periods of low flow where the taking would affect the established threshold for that watercourse. In dealing with developments such as golf courses, new golf courses and changes in designs to older golf courses, designers have looked at retaining more runoff from overland flow into larger irrigation reservoirs. This ensures that there is less reliance on water taking, particularly during drought or periods of low precipitation. In many cases, these reservoirs are large enough to supply other ponds scattered throughout the course that are in place for aesthetics or "water hazards" rather than for irrigation purposes. With many of these new designs or re-designs, conservation authorities will work with the Ministry of the Environment and the applicant to ensure that any water taking from a watercourse will not result in environment impacts by constructing the intakes so that water can only be harvested during high flows.

In summary, the main role and mandate of a conservation authority is to provide for programs that protect and enhance the natural resources of its watershed and to provide for the protection of property and life through regulatory control pertaining to natural hazards. Hopefully, this article has helped explain some of the history of the conservation authority movement and some of the tools, programs and partnerships that are utilized by conservation authorities to fulfill their role and mandate. ♦

WATER EFFICIENCY IN HALTON REGION

WAYNE GALLIHER, WATER/WASTEWATER OUTREACH COORDINATOR, HALTON REGION

With the increased temperatures experienced during summer periods, water utilities across Ontario face an increase of peak in water servicing demands attributed to recreational tasks such as car washing and filling of swimming pools, seasonal irrigation of lawns and gardens, and increased personal water consumption. Should periods of peak consumption persist and recovery of water distribution system reservoirs be unachievable or overall system pumping capacities thresholds be threatened, many water service utilities are required to put in place watering bans and/or restrictions to ensure adequate levels of water are reserved for residential and business based consumption requirements and fire protection purposes.

Residential water consumption can as much as double in summer periods. It is in the best interest of water service utilities to limit the operational impacts of unnecessary treatment when looking to the added costs of additional treatment chemicals needs, energy used in treatment and distribution, and the secondary treatment of added wastewater volumes experienced under increased water peak consumption periods. As such, the introduction of numerous municipal based water efficiency programs and policies have fast become the most cost effective and environmentally friendly means in achieving reductions, and creating additional capacity, to limit the operational impacts experienced during peak summer periods.

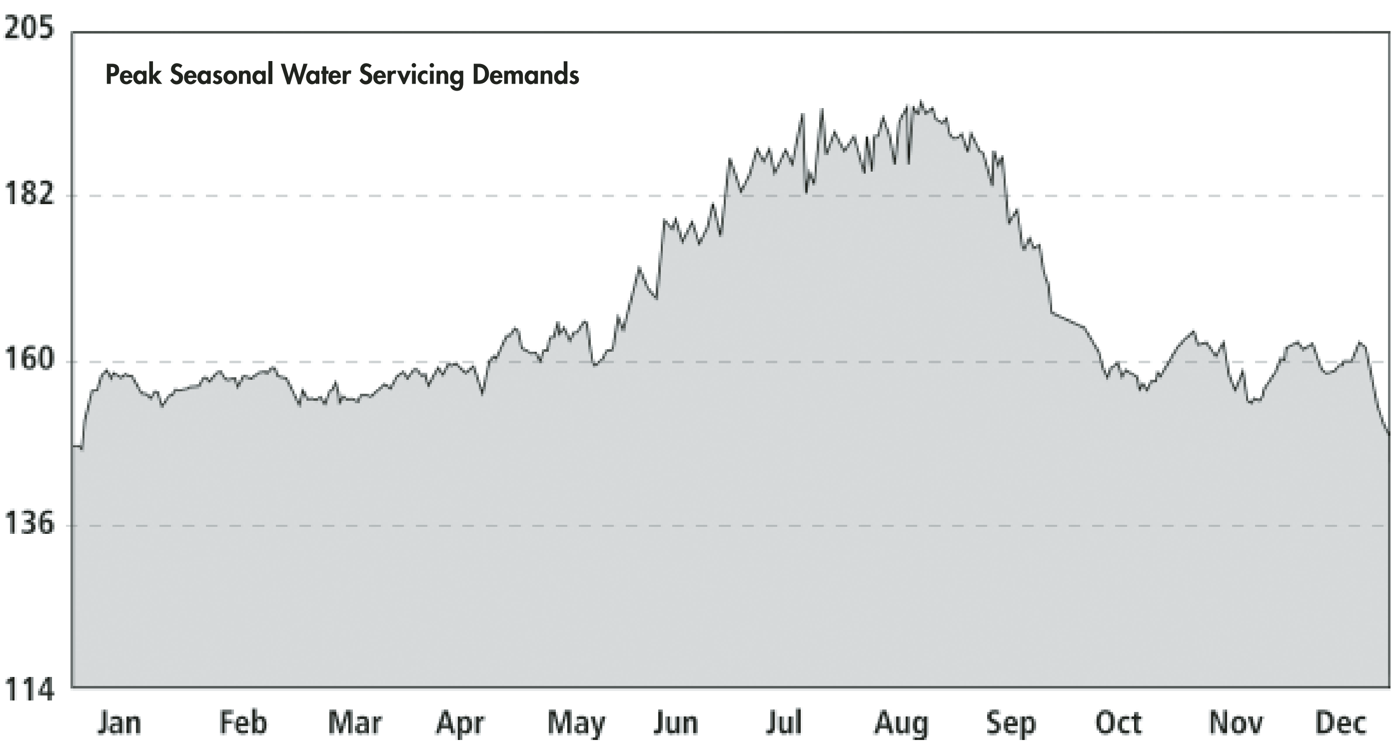
In working to reduce the impacts of peak seasonal water servicing demands and to demonstrate environmental stewardship of the region's water resources, Halton Region has employed a combination of demand side management, public education and bylaw based water conservation measures.

Water Balance Audits

As part of Halton's demand side management initiatives, an annual *Water Balance Audit* is completed to assess the overall efficiency of each of the region's water distribution systems through a comparison of water production, billed water consumption and the calculation of water volumes attributed to non-metered tasks. In response to levels of lost water identified through the audit, Halton has employed an ongoing leak detection program to assess daily water flows into areas of suspected loss and to pinpoint water leakage in each water distribution system. Further to leak detection studies, demand side management initiatives have also transcended to include the region offering voluntary water use audits to large Industrial, Commercial and Institutional (ICI) water users within the Halton Hills groundwater based communities of Acton and Georgetown. Through this initiative, representatives of the Halton water conservation program assess how water is utilized at each site, and following a flow monitoring period at the site, provide a detailed report of possible measures which could be undertaken to limit the use of excess volumes of water observed.

Educating the Public

To promote public knowledge of water conservation practices and programs



within the community, Halton staff has continually been involved with community based outreach events throughout Halton Region. In continuing with water conservation based public education, Halton Region and Conservation Halton partnered to provide the inaugural Halton Children's Water Festival in September of 2006 at Kelso Conservation Area in Milton, Ontario. Throughout the three-day event, over 3,000 grades 3, 4 and 5 students from across Halton Region participated in 56 interactive Ontario curriculum based activity centres focused on the main festival themes of water conservation, water health and safety, water protection, water science and technology and water stewardship. With the high success of the inaugural event, planning of the second Halton Children's Water Festival is currently underway. The 2007 event planned for September 25, 26, and 27, 2007, will again be held at Kelso Conservation Area and feature over 50 interactive activity centres for grades 2, 3, 4 and 5 Halton Catholic District School Board and Halton District School Board students.

Implementing Bylaws

The third measure used for water efficiency is the *Halton Water Use Bylaw* (Bylaw 42-04). This bylaw distinguishes permitted usages of water, provides specification as to qualified personnel who may operate water system infrastructure, specification regarding the components of water system infrastructure, and outlines water usage violations and penalties under violation of the bylaw. In addition to the terms listed above, the *Halton Water Usage Bylaw* also provides the ability to implement water usage bans, restrictions and watering policies. With reference to this, Halton Region introduces the odd and even day watering policy each spring to limit excessive levels of irrigation as an industry best practice in water resource management and stewardship.

Further Initiatives

In continuing to employ water efficiency measures, Halton Region is currently working towards the introduction of numerous programs including a residential toilet rebate pilot program, an ICI pre-rinse spray valve replacement program, school based water and wastewater Ontario curriculum based outreach program, and a landscape assessment program to promote outdoor water efficiency through the use of drought tolerant and native plants in home landscaping.

Furthermore, Halton Region has currently started development of the *Halton Water Efficiency Master Plan* to provide a measurable, sustainable and achievable water efficiency strategy. The plan, upon endorsement by Halton Regional Council, will see the introduction of an enhanced water conservation based program strategy and the introduction of an overall water efficiency reduction goal to be achieved over the next decade.

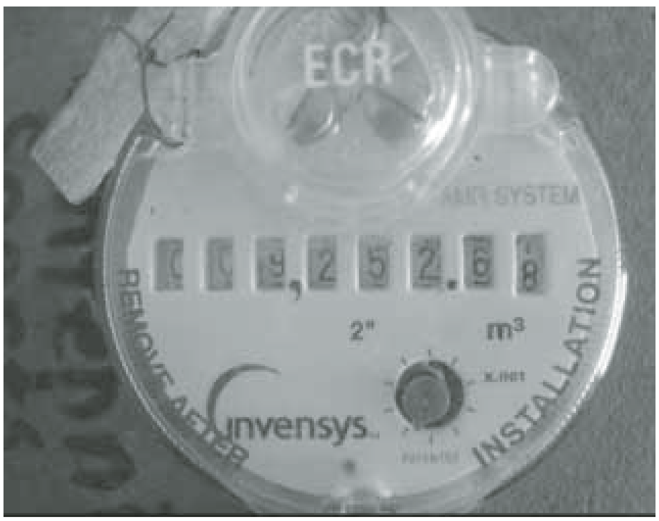
For more information on the *Halton Water Conservation Program*, please visit www.halton.ca/waterconservation. ♦

DEVELOPING AN IRRIGATION BASELINE

ARTICLE & PHOTOGRAPHS BY GREGORY SNAITH, P.ENG., ENVIROIRRIGATION™ ENGINEERING INC.

Using Water to Ensure Safety

A critical water use balance is essential to maintain a healthy, safe and functional turf sports field. Under irrigating a sports field may result in a playing surface that becomes dry, compacted and less safe for athletes. Sports turf managers require historical water use baselines which provide a datum to measure from while implementing higher water management technologies.



Daily Peak Demands

During the summer months, many cities and towns across North America experience daily peak demands which approach the rated capacity of water distribution infrastructure. In critical situations, this limits available water resources for emergency response and fire protection. While outdoor water use bans and restriction programs are created to decrease daily peak demands, these water programs are often in conflict with the required water to ensure athlete safety, functional turf sustainability and Integrated Pest Management program support.

Implementing the Water Efficiency Plan

An effective *Water Efficiency Plan* should separate the *Water Efficiency Program for Sports Fields* from the *Outdoor Landscape Water Use Program*. It only makes sense, since one is to provide a safe sports environment for the public while the other functions to achieve beautification. Since irrigation is generally considered a high water use sector, golf course superintendents and sports field managers should have strategic influence on the development of water efficiency plans. The double win opportunity would be a partnership between the city and the water purveyor (often the region) to promote water saving incentives including irrigation system performance auditing, training, technology upgrades and water use monitoring. For most cities, if water efficiency programs are not implemented, they will require major infrastructure expansion to accommodate future population growth.

Justifying Water Usage

Justifying water use for irrigation is based on the area of playing surface multiplied by the depth of water required. To implement water efficiency, it is essential every sports turf manager understands:

- soil water holding capacity
- drainage
- infiltration rates
- compaction
- evapotranspiration rates

A recommended resource on these topics is *Understanding Turf Management* written by Dr. Robert Sheard and published by the Sports Turf Association.

Typical Irrigation Baseline vs. ET Management

The majority of existing irrigation controllers rely on a weekly schedule of irrigation cycles that remain fixed until the sports turf manager adjusts them. Self adjusting water efficient irrigation controllers take into account both on-site rainfall and changing weather. Case studies have shown such automatic adjustments can account for seasonal water savings up to 30% or higher. Irrigation is only required to make up for the lack of timely and effective rainfall. For example, an effective rainfall of 10 mm on a 6,000 m^2 soccer field is worth $120 if during a dry period the same amount was added by irrigation and the water cost was $2 per m^3.

Record Keeping is Essential

Measurement of the irrigation system's performance whether a golf course, sports field or a commercial site, is the critical step in identifying baseline water use. Personal auditing experience proves that no one can judge with accuracy the efficiency of any system until it is measured professionally.

Verify Water Usage With Dedicated Flow Meters

Dedicated water meters are excellent water usage management tools and take the estimation out of volume calculations. The strategic key to implementing any water efficiency plan is to first establish and provide the historical water use baseline. This can be done by monitoring a dedicated water meter on a monthly basis and by providing a performance audit to the existing system.

Historical Water Use Baseline (HWUB)

The HWUB for any irrigation system is affected by:

1. Original irrigation design (ideally done by Certified Irrigation Designer independent from the sale or installation of any product).
2. Original irrigation installation (ideally installed by a Certified Irrigation Contractor with same project experience and inspected by a certified designer).
3. Maintenance of system (routinely checked and repaired).

4. Management of system (ideally by implementing monitoring and seasonal changes using Smart Water Application Technologies).

Once a water use baseline has been established it can then be utilized as a datum against the following:

1. Measure baseline against seasonal ET requirements (usually measured in mm per day, week or month).
2. Measure baseline against expected water efficiency technology performance (it is realistic to expect a rotor zone to operate at an overall efficiency of 75%).
3. Measure baseline against goals and/or objectives of a *Water Efficiency Plan* (the goal may be to decrease the water use by a realistic 20-30%).

The Irrigation Association, consultant, manufacturer, contractor and the distributor are all key team members playing their appropriate roles in providing technical and educational support for all irrigation systems. No matter how simple or complicated an irrigation system is, one thing is for certain, it is very difficult to measure improved water efficiency practices without first establishing the water use baseline. Remember, you cannot effectively manage that which has not been effectively measured. ♦

USE IT OR LOSE IT: BMPs FOR WATER MANAGEMENT

PAM CHARBONNEAU, TURFGRASS SPECIALIST, OMAFRA

Use it wisely or lose it should be the real slogan here. The goal is to provide turf with the right amount of water when it is needed and at the lowest cost and the least impact on the environment. There are negative consequences when turf receives too little or too much water. Not enough water can result in drought stress, thinning, localized dry spots and dormancy. Too much water, on the other hand, can result in shallow root growth, increased soil compaction, susceptibility to disease, leaching of nutrients, wet wilt and a waste of water due to runoff or drainage.

Turf & Water Interactions

A turfgrass plant is composed of 90% water. Water is also needed in every stage of plant growth. If water levels within a plant get below a critical level the plant will die. As little as a 10% reduction in turf water content may be sufficient to cause death. Water is needed for photosynthesis, cell division, temperature control and nutrient movement. The equation for photosynthesis showing the role of water (H_20) is below:

$$6CO_2 + 6H_20 \xrightarrow{\text{light}} C_6H_{12}O_6 + 60_2$$

Photosynthesis and cell division account for 1% of a plant's water needs. The majority of a plant's water needs are for temperature control and nutrient movement and these account for 99% of a plant's water need. All nutrients are moved into plants through the soil solution. This nutrient rich solution is taken up by the roots and transported via the xylem in solution. This movement occurs from the roots to all parts of the plant.

IMPORTANT
TABLES/FIGURES AVAILABLE
★ as an insert ★

Cooling of turfgrass plants is made possible because of water loss from the plant through transpiration (as a vapour). Ninety percent of the water loss is through the stomates. In a turf system, water is also lost from the soil through evaporation. There is a combined loss of water from the soil by evaporation and by the plant through transpiration and this is called evapotranspiration (ET). ET is difficult to measure, but it can be estimated. It is influenced by sunlight, soil and air temperature, relative humidity, wind speed, turfgrass species, height of cut of turf and rainfall. It is measured in inches/day, inches/week or mm/day. Evapotranspiration is used to calculate plant water requirements. It is estimated with a device called an evaporation pan. This gives the amount of water that evaporates from a flat shiny surface. It must then be adjusted for each crop and for each microclimate. One equation that is used to estimate plant water requirements is below:

$$PRW = ET \times K_c \times K_{mc}$$

PRW = plant water requirement
ET = evapotranspiration
K_c = crop coefficient
K_{mc} is the microclimate factor

Crop coefficients vary with each type of grass species and the height at which they are maintained. Most crop coefficients are based on seasonal averages. Some cool season turfgrass crop coefficients are listed in Table 1 (see insert).

Microclimates may also vary from area to area and for the purpose of this article, from sports field to sports field. The microclimate factor is a correction factor that relates to things such as proximity to buildings, paved surfaces, slope, shade and wind. A microclimate factor in a full sun sports field with heat reflecting and heat generating buildings nearby that is exposed to the prevailing winds would have a high K_{mc} and a microclimate with shade and no wind would have a low K_{mc}. In general there are three K_{mc} microclimate correction factors: high = 1.4, medium = 1 and low = 0.5.

An Alternative Method of Estimating Evapotranspiration

Some work done at the Cambridge Research Station by Dr. Robert Sheard came up with a way to estimate pan evapotranspiration based on observed weather conditions. This is an alternative method to having your own evaporation pan, which is easier, but may be a bit less accurate. Table 2 gives the estimated pan ET in millimeters based on weather observations at 1:00 pm.

A combination of the visual estimates of humidity and wind in addition to an observed temperature gives the estimate of pan evaporation. This then needs to be corrected for grass with the season correction factors found in Table 3.

ET calculation example:
Date – July
Sun – Sunny
Temperature – 27ºC
Humidity – low
Wind – low
Estimated pan evaporation from Table 2 (7.5) x seasonal correction factor from Table 3 (.75) = estimate of grass ET (5.5 mm) for that day.

Soil and Water Interactions

The amount of water a plant needs is influenced by soil particle size, soil particle size distribution (soil classification) and root zone depth. Soils can be classified according to their particle size into sand, silt and clay. Sands can be further divided into five categories: very fine sand, fine sand, medium sand, coarse sand and very coarse sand. Table 4 shows the particle size diameter of coarse sand down to silt and clay.

For every field that you are responsible for irrigating within your municipality, it is very important to know the soil classification or particle size distribution of that field. Without this information, it is almost impossible to accurately deliver the right amount of irrigation. One way of obtaining this information is to have a soil laboratory run a soil texture analysis of every field. This is a useful exercise and only needs to be done once in the life of a sports field. A cheaper and quicker method is to simply use the mason jar test and a soil texture triangle. Just follow the steps below. Figure 1 shows a mason jar with roughly 80% sand and 20% silt.

1) Fill a mason jar 1/3 full of a random sample of soil from one field.
2) Pack it down and mark the level with a permanent marker.
3) Add water to fill the jar 3/4 full.
4) Shake vigorously.
5) Let sit for 5 minutes.
6) Measure the sand layer (the one on the bottom of the jar) as a percent of the depth of the original soil.
7) Measure the silt layer (the one above the sand layer) as a percent of the depth of the original soil.
8) Add the percent sand and percent silt together and subtract that from 100 to get percent clay (the clay is still suspended in the water).

Figure 1: Mason Jar Test

Now that you know that you have an 80% sand and 20% silt soil you can go to the soil texture triangle (Figure 2) to determine the soil classification. Follow the percent sand arrow over to 80 and follow the % silt down to 20 and follow each of those lines to the point where they intersect. In our example, we end up in the loamy sand area of the triangle. Soil texture affects plant available water and water infiltration rates. Both of these are important factors in determining efficient irrigation scheduling.

Infiltration rate is a measure of how quickly water enters soil. It is greatest at the beginning of an irrigation event or rainfall event and again it is influenced by soil texture. Infiltration rates of each soil or each field can be measured in one of two ways. A double ring infiltrometer is the most accurate way of measuring infiltration rates. Another way is to simply put on the irrigation system and measure the time until runoff. Infiltration rates can also be estimated if you know the soil texture. Table 5 gives a list of the basic infiltration rates of six different soil classifications.

Another important aspect of a soil is its available water. This is the amount of water stored in a soil between field capacity and permanent wilt. Another way to think of it is the amount of water that the plant can extract from the soil. In fine textured soils such as a clay loam, some of the water is held so tightly onto the soil particles that it is not available to the plant. In a coarse textured soil, some of the water applied to a soil is not available to a plant because it is lost through drainage. Table 6 gives the available water in mm based on soil texture. If you are using the calculation based on soil texture, the plant available water is the available water multiplied by the active root zone depth. There are two instruments that can be used in the field to measure plant available water: a time domain reflectometry probe (TDR probe) and a frequency domain reflectometry probe (Theta probe). Both of these methods measure volumetric water content.

Plant available water is the available water which can be measured in the field or it can be calculated based on soil texture. To calculate plant available water:

Plant available water = available water (from Table 6) x root zone depth

Example:
Sandy loam soil with a 300 mm root zone
Plant Available Water (PAW) = (available water from Table 6) 0.12 mm water/mm soil x (soil root zone depth) 300 mm soil
PAW = 36 mm water

Another important concept in the field of irrigation is how much water can be depleted from a soil before there are adverse affects to the plant. This is called the maximum allowable depletion. In general, it is agreed upon that if plant available water is allowed to deplete to 50% before re-applying water that there will be no harmful effects on the turfgrass plant.

Below is an example to help put all of the pieces together. Table 7 shows an example of a water budget. The assumptions in the example are:

- A sandy loam root zone
- Rooting depth 300 m
- Plant available water is 300 mm x 0.12 mm/mm = 36 mm
- Want to irrigate when 50% of available moisture is depleted (ie. at 18 mm)
- Assume field capacity on day 1 = 36 mm plant available water

This example shows that this particular field, when ET rates are high, the field needs only to be irrigated every second or third day.

Sprinkler Performance

Now that the plant side is taken care of, let us look at irrigation system performance. In order to irrigate efficiently, you must have an irrigation system that is performing properly. Irrigation system performance can be determined by an irrigation audit. This can be done in-house or you can hire an irrigation auditor to perform it. An irrigation audit will ensure that all sprinkler heads are level and that the pressure is relatively uniform. It will also determine the distribution uniformity (DU) of the irrigation system and this is calculated by measuring catch device volumes in the field. An irrigation audit will also determine the precipitation rate (PR). This is the rate at which water is applied per unit time (in/hour or mm/hour) and it is often referred to as the application rate. With this information you can determine your run time multiplier and finally your maximum run time cycle.

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Irrigation Scheduling

The next question should be "How long do I have to run my irrigation system to deliver 14 mm or 24 mm of irrigation?". If you have performed an irrigation audit, you can easily determine your run time. To determine this you need to know the following:

- run time multiplier (RTM)
- distribution uniformity of the lower quarter (DU) (from irrigation audit)
- precipitation rate (PR) (from irrigation audit)
- base run time(RT_b) RT_b = plant water requirement/precipitation rate x 60.

With the above information you can then:
- calculate the adjusted run time (RT_{adj}). $RT_{adj} = RT_b$ x RTM
- calculate the maximum run time/cycle = infiltration rate/precipitation rate x 60

The run time multiplier is a correction factor that is used to compensate for non-uniformity of distribution of an irrigation system. Run time multipliers can be found in the Certified Golf Irrigation Auditor workbook put out by the Irrigation Association and they can also be found on the internet. The infiltration rate can either be estimated based on soil texture or you can determine it with a double ring infiltrometer as discussed earlier in the article.

Example run time calculations based on the water budget example above:
- Base run time RT_b = PWR/PR (24 mm/ 15 mm (from irrigation audit) x 60) = 96 minutes
- Adjusted run time RT_b x RTM (96 x 1.22 = 117 minutes)
- Infiltration rate – 14 mm (from Table 5)
- Maximum run time/cycle
- Infiltration rate/precipitation rate x 60 = 14 mm per hr/15 mm x 60 = 56 minutes
- The maximum time this zone should be run to avoid runoff is 56 minutes. Basically, two run cycles of roughly 56 minutes will deliver the required amount of water to recharge the root zone in this water budget example.

Irrigation Checklist

This checklist below gives a quick overview of the information and/or equipment needed to be able to apply the right amount of water to turf.

1) Determine soil texture of each irrigated field (mason jar or lab).
2) Make note of the infiltration rate (based on soil texture, double ring infiltrometer or observation of time to runoff) and available water (based on soil texture) and root zone depth for each field.
3) Calculate plant available water = available water x root zone depth.
4) Perform an irrigation audit to determine precipitation rate and distribution uniformity.
5) Keep track of ET rates based on temperature, humidity and wind.
6) Have a method for measuring rainfall and a rain shut off feature.
7) Use the water budget to schedule irrigation.
8) Use run time calculations to determine how long to water.
9) Schedule to water only in early morning (low wind and less evaporation).
10) Ground truth by inspecting fields to make sure the turf is getting adequate water and that there are no over-watered, under-watered areas or localized dry spots.
11) Have a dedicated knowledgeable staff person in charge of irrigation.
12) Don't forget other cultural practices for maintaining healthy turf:
- Mow as high as possible and frequently enough to maintain a stress-free plant.
- Alleviate compaction (core aeration, etc.) which helps maximize infiltration rate.
- Control thatch.
- Fertilize according to the plant's needs.

Abbreviations

DU =	disribution uniformity
ET =	evapotranspiration
K_c =	crop coefficient
K_{mc} =	microclimate factor
PAW =	plant available water
PR =	precipitation rate
PWR =	plant water requirements
RTM =	run time multiplier
RT_{adj} =	adjusted run time
RT_b =	base run time

References

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