Stormwater Retainment for Golf Course Irrigation

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Introduction

Water continues to be a critical resource for the maintenance of quality golf courses. Even in water-rich areas like the Great Lakes Basin, states are actively regulating water use and these regulations are increasing. New or expanded sources of water are going to be under more intense scrutiny as a result of increased regulation. Water already is, or has the potential to be, the limiting factor in the management of existing golf courses and the construction of new golf courses.

Michigan has 13 pieces of pending legislation related to water use. An existing law requires golf courses to report annual water use. A conflict resolution process between water users is in place legislatively. Mapping of Michigan's groundwater resources was recently completed and a Groundwater Conservation Advisory Council has been established. Craig Hoffman, golf course superintendent at The Rock on Drummond Island serves on this council representing non-agricultural irrigators.

Water use legislation in Michigan was first stimulated by regional activity in 1985 with the signing of the Great Lakes Charter by the governors of the eight Great Lakes states and premiers from two Canadian provinces. The Great Lakes Charter is designed to protect and conserve water in the Great Lakes Basin and to prevent large diversions of water out of the basin. Years of negotiation has led to the Annex 2001 Implementing Agreements draft that defines the actual means to accomplish the goals set forth in the Charter. Concurrent to this Annex discussion, the comprehensive water legislation proposed in Michigan is designed to complement the proposed Annex language.

The Great Lakes Basin is not the first and only area of the country dealing with water issues and subsequent water policy that will impact golf courses. In fact, other parts of the country like the arid southwest, California, and Florida have been addressing water issues and have set policies and passed legislation that currently impact the golf industry. A consistent theme through all discussions of water throughout the country is protection and conservation of water resources.

Concurrent to the water policy issues is the Phase II Stormwater regulations issued by the U.S. EPA. These mandates affect large communities and put a significant burden on local governments to meet the compliance goals set forth by the U.S. EPA. In some cases, Phase II issues have been linked to the development of a stormwater retainment system on a golf course. The opportunity for golf courses to be part of community solutions to stormwater management is significant if research can both quantify and qualify the issues to be answered in developing a stormwater management system for turfgrass irrigation.

This research will evaluate the retainment of stormwater on golf courses as a water source for irrigation and the environmental benefits of these systems to the community in which they are located. Water quality, the cost benefit of constructing a retainment system, and how these systems can help a community address water related issues will be evaluated in this research. Stormwater retainment systems on three golf courses in

Michigan will be evaluated for water quality and the cost benefit they provide as compared to three golf courses that irrigate out of a holding pond recharged with a well.

Experimental Objectives

1. To compare a set of water quality parameters in a stormwater retention system to a well recharged holding pond and determine if water quality issues will be a limiting factor with a stormwater retention system.

2. To determine a cost benefit analysis of a stormwater retention system compared to an irrigation system that uses a well recharged holding pond.

3. To identify the role of the golf course superintendent in the development, construction and management of a stormwater retention system.

4. To determine the environmental benefits of these systems to the community in which they are located.

Results

Objective 1: To compare a set of water quality parameters in a stormwater retention system to a well recharged holding pond and determine if water quality issues will be a limiting factor with a stormwater retention system.

In 2006 we sampled irrigation water from seven different golf courses. We had originally proposed to sample from six golf courses but one golf course dropped out of the project, one was added to replace it, and two golf courses were sampled from the Indianwood complex. Both of the golf courses at the Indianwood complex are well recharged irrigation ponds. For the stormwater retainment golf courses, Groesbeck golf course was dropped from the study due to the fact that they non longer have a superintendent in charge of the facility and it was very challenging to coordinate sample collection due to the lack of a superintendent in charge. We determined that the Westwynd golf course which actually uses a combination of stormwater retainment and well for irrigation would take the place of Groesbeck golf course for the storm water retainment assessment. Forest Akers West golf course was then added to the well recharged portion of the study.

The cooperating courses and superintendents are:

Stormwater Retainment:

The Wyndgate/Westwynd	Deron Crouse
Lochmoor Club	Mike Jones, CGCS
Northville Hills	Andy Thoresen
Groesbeck Golf Course (dropped from the study)	

Well Recharged Pond:

Walnut Hills	Kurt Thuemmel
Indianwood (New and Old Courses)	Aaron Mitzelfeld
Forest Akers West	Sean O'Connor

Irrigation water was sampled from April through November. We had initially proposed beginning sampling in March but due to the weather conditions present in 2006, none of the golf courses had their irrigation systems primed by the end of March. In fact Westwynd golf course did not prime their irrigation system until May so we did not have a sample from Westwynd in March or April. A complete set of irrigation water quality parameters were sampled including: alkalinity, conductivity, pH, total dissolved solids, chloride, nitrogen (nitrate + nitrite), phosphorus (orthophosphorus), carbonate, bicarbonate, boron, calcium, iron, potassium, magnesium, manganese, sodium, sulfur (as sulfate), sodium adsorption ratio, oil and grease, and hydrocarbons. Samples were analyzed by A & L Great Lakes Laboratories, Ft. Wayne, Indiana.

Irrigation Water Quality Results 2006

In 2006 we generated a tremendous amount of data on irrigation water quality parameters from the seven golf courses involved in the study. For the purposes of this preliminary report we have taken the mean values from the well and stormwater retention golf courses and presented the data in Table 1. Upon conclusion of the sampling in 2007 we will provide more detailed comparisons both within each golf course between years and within the same year, and between the two categories of golf courses surveyed. We would certainly be willing to provide the detailed water quality tests from each golf course if requested.

Table 1 presents some of the key irrigation water quality parameters from the storm water and well irrigation golf courses. It is interesting to note that for almost all of the parameters tested the golf courses that collect and irrigate with storm water had lower values. The two irrigation parameters that were higher for the stormwater courses were phosphorus (orthophosphorus) and nitrogen (nitrate + nitrite). This result is probably not unexpected since there are many sources or phosphorus and nitrogen in the environment that could be captured in stormwater runoff including off-target fertilizer applications and decomposing plant material. The mean value of phosphorus was relatively low at 0.36 ppm and the mean value for nitrogen was 0.2 ppm. These values could be viewed as positives due to the nutrient content of the irrigation water, albeit the concentration was low.

There was never a detectable level of oil and grease, or hydrocarbons in any of the irrigation water quality samples from either the stormwater retainment or well irrigation golf courses. The presence of oil and grease, or hydrocarbons in irrigation water could be a concern for golf courses collecting stormwater for irrigation purposes, but even samplings immediately following rainfall events did not result in a detectable concentration in any of the samples. This should alleviate some of the concerns associated with collecting stormwater runoff from surrounding impervious surfaces.

Irrigation Water Quality Results 2007

Data for irrigation water quality samples from the stormwater retainment systems at Lochmoor Club and Northville Hills are presented in Tables 2 and 3. Similar to the results from 2006, the irrigation water quality from these systems was acceptable and similar if not better to the irrigation water quality from golf courses using a well system. Also, there were never any oil and grease, or hydrocarbons detected in any of the samples collected. Our conclusions from two years of collecting irrigation water quality samples from stormwater retainment systems indicated that although are sampling size is small, it appears that collected stormwater is acceptable for turfgrass irrigation purposes.

Objectives 2, 3, and 4:

In 2006 and 2007, we had discussions with all of the superintendents, on the stormwater retainment golf courses, with respect to their role in the development of storwater retainment systems. Mike Jones at Lochmoor C.C. is currently in the process of having additional stormwater directed to the golf course as part of a local street reconstruction process. Especially in the case of Lochmoor C.C. we will be able to quantify the cost benefit analysis of constructing the stormwater retainment systems and the monetary savings with using captured stormwater when compared to golf courses using a well recharged irrigation pond system. Unfortunately, Mike Jones' contract with Lochmoor Club was not renewed for 2008 and we are currently in the process of working with Mike to try and finalize the cost/benefit analysis of the stormwater retainment system which he was responsible for implementing.

Table 1. 2006 Mean irrigation water quality parameter values for the well and stormwater retainment irrigation golf courses.

	Well	Stormwater
Alkalinity, CaCO3	198.75†	139.96
Conductivity	0.63 mmho/cm	0.52 mmho/cm
pH	7.92	7.93
Solids, Total dissolved	438.61	360.18
Chloride	69.83	48.00
Nitrogen, Nitrate+Nitrite (as N)	0.17	0.21
Phosphorus, Ortho (as P)	BDL‡	0.36
Carbonate (CO3)	1.50	1.50
Bicarbonate (HCO3)	239.56	169.15
Boron	0.35	0.30
Calcium	118.01	59.50
Iron	0.61	0.25
Potassium	3.10	4.99
Magnesium	39.32	21.56
Manganese	0.23	BDL
Sodium	50.87	22.58
Sulfur (as Sulfate)	36.31	40.64
Sodium Adsorption Ratio	1.17	0.64
Oil & grease	BDL	BDL
Hydrocarbons	BDL	BDL

† All units, with the exception of pH, are mg/L (ppm) unless otherwise indicated.
‡ BDL = beyond detectable limit

Table 2. Irrigation Water Quality Analysis from the stormwater retainment system at Lochmoor Club, Gross Pointe Farms, MI.

Date	5/10/207	5/14/2007	6/7/2007	6/26/2007	8/3/2007	9/6/2007
Alkalinity, CaCO3		73	78	150	74	
Conductivity		0.01 mmho/cm	0.47	0.48	0.23	
pH		7.7	8.3	8	7.7	
Solids, Total dissolved		288	301	307	149	
Temperature at pH reading		19.1	18.1	22.1	19.8	
Chloride		12.63	12.4	13.48	8.63	
Nitrogen, Nitrate+Nitrite (as N)		0.19	BDL	0.18	BDL	
Phosphorus, Ortho (as P)		BDL	BDL	0.2	BDL	
Carbonate (CO3)		BDL	BDL	BDL	BDL	
Bicarbonate (HCO3)		89	93	182	89	
Boron		BDL	BDL	BDL	BDL	
Calcium		58.1	68.9	60.5	27.6	
Iron		0.17	BDL	0.21	BDL	
Potassium		6.51	7.36	7.2	0.96	
Magnesium		16.23	19.53	17.59	7.62	
Manganese		BDL	0.03	0.06	BDL	
Sodium		6.1	6.9	7.1	3.9	
Sulfur (as Sulfate)		69	70	74	26	
Sodium Adsorption Ratio		0.2	0.2	0.2	0.2	
Oil & grease	BDL					BDL
Hydrocarbons	BDL					BDL

*** all units are mg/L unless otherwise specified**

Table 3. Irrigation Water Quality Analysis from the stormwater retainment system at Northville Hills, Northville, MI.

Date	5/10/2007	5/14/2007	6/7/2007	6/26/2007	3/2/2007	9/6/2007
Alkalinity, CaCO3		81	122	288	250	
Conductivity		0.64	0.73	0.79	0.67	
pH		8.3	7.6	7.9	7.8	
Solids, Total dissolved		410	467	506	429	
Temperature at pH reading		19	17.8	22.2	19.7	
Chloride		81.82	56.31	38.35	29.98	
Nitrogen, Nitrate+Nitrite (as N)		BDL	BDL	BDL	BDL	
Phosphorus, Ortho (as P)		BDL	BDL	BDL	BDL	
Carbonate (CO3)		BDL	BDL	2	2	
Bicarbonate (HCO3)		98	148	347	301	
Boron		BDL	BDL	BDL	BDL	
Calcium		56.6	91.8	92.4	79.8	
Iron		0.35	0.24	0.19	0.04	
Potassium		2.66	2.57	1.99	3.52	
Magnesium		17.27	33.33	34.48	29.44	
Manganese		BDL	BDL	BDL	BDL	
Sodium		41.5	29	18.7	14.9	
Sulfur (as Sulfate)		41	66	80	76	
Sodium Adsorption Ratio		1.2	0.7	0.4	0.4	
Oil & grease	BDL					BDL
Hydrocarbons	BDL					BDL

*** all units are mg/L unless otherwise specified**

Table 4. Irrigation Water Quality Analysis from the irrigation well at Indianwood Country Club, Lake Orion, MI.

Date	5/10/2007	5/14/2007	6/7/2007	6/29/2007	8/2/2007	9/6/2007
Alkalinity, CaCO3		95	92	162	334	
Conductivity		.6 mmho/cm	0.61	0.57	0.53	
pH		8.2	8.2	8.3	8.3	
Solids, Total dissolved		384	390	365	341	
Temperature at pH reading		19.1	18.9	22	19.8	
Chloride		71.62	75.61	73.69	79.85	
Nitrogen, Nitrate+Nitrite (as N)		BDL	BDL	BDL	BDL	
Phosphorus, Ortho (as P)		BDL	BDL	BDL	BDL	
Carbonate (CO3)		BDL	BDL	1	4	
Bicarbonate (HCO3)		114	110	195	400	
Boron		BDL	BDL	BDL	BDL	
Calcium		54.4	58.2	42.6	31.2	
Iron		0.07	BDL	0.02	BDL	
Potassium		0.56	1.2	0.91	1.03	
Magnesium		18.62	20.81	19.45	20.6	
Manganese		BDL	BDL	BDL	BDL	
Sodium		37.3	40.6	39.9	42.4	
Sulfur (as Sulfate)		18	18	18	18	
Sodium Adsorption Ratio		1.1	1.2	1.3	1.4	
Oil & grease	BDL					BDL
Hydrocarbons	BDL					BDL

*** all units are mg/L unless otherwise specified**