Effluent Water: A Potential Irrigation Source in Wisconsin?

By Brad DeBels, *Recipient of Terry and Kathleen Kurth Wisconsin Distinguished Graduate Fellowship, Department of Soil Science, University of Wisconsin-Madison*

The importance of preserving potable water for the future has never been more evident than the present. Growing populations are extracting large amounts of surface and groundwater for municipal and domestic use. High water demand during times of drought often leave municipal water supplies depleted resulting in water use restrictions to conserve water. Irrigation accounts for approximately 80% of total water use in the United States. For turfgrass managers irrigation restrictions directly affect their livelihood. New technology and alternative water supplies must be considered in making irrigation more environmentally friendly.

Irrigation technology has improved application efficiency while research and education has provided turf managers with improved ways to determine irrigation needs and scheduling through monitoring soil moisture and evapotranspiration. Throughout the United States golf courses are also turning to effluent water as an irrigation source. Effluent water is water that has undergone one cycle of use and treated to Congress and EPA standards. More than 37% of golf courses in the Southwest and 24% in the Southeast use effluent water. The Midwest region hasn't yet utilized this resource to the degree of other regions, as only 3% of golf courses irrigate with effluent water (Throssell, 2009). Many possible explanations exist for this phenomenon.

The available water supply in the Midwest region has currently kept water costs relatively low, from less than $1.75/1000 gallons to free-of-charge. Often effluent water may also be free, but utilizing it doesn't come without an initial and hidden costs. In areas that haven't been retrofitted with modern infrastructure to transport and store effluent water, initially high expenses will be incurred to install these systems. Turfgrass managers will have to adjust management practices to account for a less pure water supply, which will alter soil and plant properties. Research is being conducted to determine the possible impacts effluent water will have on soil and turf properties, but has primarily taken place in regions with limited rainfall. Wisconsin receives nearly 30 in/yr, which may play a significant role in minimizing negative impacts.

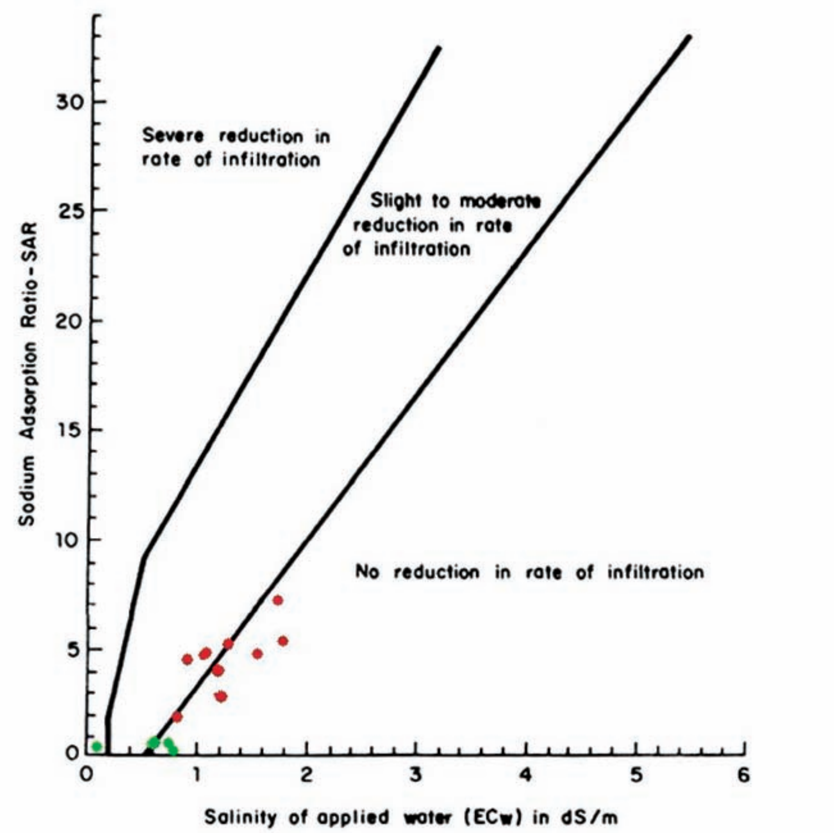

Figure 1. Predicted effect of EC_w and SAR on soil infiltration from Wisconsin water samples (each dot represents one water sample) (red=effluent water) (green=well water samples). Figure adapted from Ayers and Westcot (1985).

Each wastewater treatment plant's (WWTP) effluent water can vary significantly depending on degree of treatment and amount of industrial land use. In February 2009 a survey of nine WWTPs throughout the state was conducted to evaluate the average quality of effluent water and its potential use as irrigation water for turfgrass in Wisconsin. The treatment facilities chosen represent a range of city sizes and locations throughout the state. The survey

Table 1. Wastewater Treatment Plant Effluent Water EC and SAR (red dots in Figure 1)

Location	E.C. (ds/m)	SAR	Infiltration Hazard based on SAR and EC
WWTP #1	1.83	7.15	**
WWTP #2	0.91	2.17	*
WWTP #3	1.28	5.37	*
WWTP #4	1.79	5.38	*
WWTP #5	1.21	2.78	*
WWTP #6	1.16	4.83	*
WWTP #7	1.24	3.88	*
WWTP #8	0.91	4.36	**
WWTP #9	1.63	4.42	*
Average	**1.33**	**4.48**	*

* No Restriction on Use, ** Slight to Moderate Restriction on Use, *** Severe Restriction on Use based on infiltration hazard according to Ayers and Westcot (1985).

primarily focused on possible negative impacts of salinity and infiltration hazard as well as the benefits of nutrients contained in the effluent water. Salinity is the accumulation of salts in the soil measured by electrical conductivity (EC - dS/m). Salts accumulate in the soil and potentially cause plant water deficits slowing plant growth. Infiltration hazard refers to the rate at which water can infiltrate the soil; the hazard is estimated based on E.C. and the Sodium Adsorption Ratio (SAR). Elevated SAR and low E.C. can result in soil dispersion and aggregate swelling which reduces soil water infiltration and hydraulic conductivity.

Table 2. Well Water from Golf Courses EC and SAR (green dots in Figure 1)

Location	E.C. (ds m^{-1})	Sodium Adsorption Ratio (SAR)	Infiltration Hazard based on SAR and EC
Madison	0.54	0.08	**
Janesville	0.77	0.18	*
La Crosse	0.72	0.44	*
Eau Claire	0.11	0.24	***
Average	**0.54**	**0.24**	**

* No Restriction on Use, ** Slight to Moderate Restriction on Use, *** Severe Restriction on Use based on infiltration hazard according to Ayers and Westcott (1985).

Table 3. Primary nutrient content in Wisconsin effluent water.

Location	N (ppm)	P (ppm)	K (ppm)
WWTP #1	12.51	0	15.03
WWTP #2	34.01	12.79	11.08
WWTP #3	24.06	1.45	15.35
WWTP #4	12.92	0.37	14.98
WWTP #5	0.3	0.01	11.65
WWTP #6	0.98	17.69	12.05
WWTP #7	9.76	0	9.52
WWTP #8	16.18	4.84	13.16
WWTP #9	18.0	0.44	9.62
Average	**14.3**	**4.2**	**12.5**

The effluent water surveyed in Wisconsin had ECw values between 0.91 and 1.83 dS/m while SAR values range between 2.17 to 7.15 (Table 1). These values are clearly greater than potable water supplies typical of golf courses across Wisconsin (Table 2). Irrigation water E.C. below 0.7 ds/m has no restrictions and E.C. values above 3.0 ds/m can have severe restrictions on use and have negative impacts on turfgrass growth. Effluent water E.C. is several times higher than that of potable water supplies found in Wisconsin, but most are not near the threshold level of 3.0 ds/m.

Managing SAR levels is relatively straightforward and is accomplished by the application of calcium (Ca^{2+}) to soil or by adding Ca^{2+} to the irrigation source. Managing salinity in arid regions requires applying irrigation in excess of crop demand which leads to leaching of salts out of the root zone. However, the consistent rainfall in the Midwest likely provides enough precipitation for adequate leaching. Because most research is predominantly performed in the southern U.S., this hypothesis has yet to be thoroughly tested. If true, adapting to effluent water use would be easier in the Midwest by decreasing the need for actively managing salt accumulation.

One potential economic and agronomic advantage of using effluent is the considerable amount of primary nutrients (N-P-K) contained in most effluent water offer economic and agronomic advantages. The presence of nutrients in irrigation water can reduce the cost of additional fertilizer inputs and facilitate turf growth. The surveyed Wisconsin WWTP effluent water samples contained an average of 14.3, 4.2 and 12.5 ppm N, P and K respectively (Table 3), although variability among WWTPs was great. The average N content accounts for nearly 1 lb N/1000 ft2 per acre foot of applied water. In some cases this may account for a substantial portion of the entire N fertilizer budget. As fertilizers costs and labor needed to apply fertilizers rise, the nutrient content and ease of application in effluent water will become even more valuable.

To utilize effluent water, contracts will often be necessary between supplier (WWTP) and user to ensure that treatment facilities don't become inundated with water supplies in times of low demand. This may force users to irrigate beyond plant requirements or require increased water storage capacities. Winter months in much of the Midwest don't require turfgrass irrigation and can pose a serious use and/or storage issue. Each regions situation possesses its own unique issues and appropriate agreements between suppliers and users will be necessary. This may prove to be the biggest obstacle to widespread adoption of effluent water for golf course irrigation. However because water is continually used and disposed, effluent water is virtually the only source of water that has a guaranteed supply. As demand increases, potable water becomes more costly, infrastructure is built and research is conducted, the use of recycled wastewater will become a core resource for irrigation even in the Midwest. Effluent water shouldn't be considered a waste, but a valuable asset in conserving potable water supplies and sustaining healthy turf growth for the future.

References:

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