Irrigation Water Supply

Irrigation water must be dependable, reliable, and of sufficient quantity and quality to accommodate turf grow-in needs and ongoing maintenance. Please see the Regulatory Framework section of this web site for more information on regulatory requirements for water withdrawal.

Irrigation Water Sources

Irrigation water can come from several sources:

- surface water from ponds, lakes, or stormwater detention ponds
- groundwater from wells
- recycled water sources
- any combined supplemental sources from rainwater and stormwater collection

Regardless of the source, irrigation water must be dependable, reliable, and of sufficient quantity and quality to accommodate turf grow-in needs and ongoing maintenance. In the northeast, irrigating with recycled water may become more common as the cost of water increases and availability of fresh water decreases, especially in large metropolitan areas. Recycled water is defined as any water that has been treated after human use and is suitable for limited reuse, including irrigation; this water is also referred to by other names such as reclaimed water, wastewater, and effluent water. Using recycled water may also be part of a nutrient reduction strategy to meet TMDLs in impaired watersheds.

For more information on the use of recycled water on golf courses, see:

- *Guidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast*
- Environmental Institute for Golf, "Using recycled water on golf courses": http://www.stma.org/sites/stma/files/pdfs/gcsaa_recyledwater_leaflet-1.pdf

Irrigation Water Quality

Water quality used for irrigation turf on golf courses must be suitable for plant growth and pose no threat to public health. Nonpotable water irrigation sources (such as recycled water or storage and detention ponds) should be tested regularly to ensure that the quality is within acceptable limits to protect soil quality and turfgrass performance. In addition, wells along the shore that supply potable water might need to be tested for salt water intrusion. Summarized below is a brief description of water quality parameters of greatest interest for irrigation water (nutrients and salinity issues); additional parameters such as pH and micronutrients may be valuable for detailed evaluations of water quality.
For more information on irrigation water quality, see:

- "Understanding Water Quality and Guidelines to Management": http://gsr.lib.msu.edu/2000s/2000/000914.pdf
- "Irrigation Water Quality Guidelines for Turfgrass Sites": http://plantscience.psu.edu/research/centers/turf/extension/factsheets/water-quality

Nutrients

Irrigation water may contain macronutrients, including phosphorus and nitrogen, as well as other nutrients that should be accounted for in nutrient management programs to avoid over fertilization. Therefore, irrigation water, especially reclaimed, recycled, or effluent water, should be tested frequently. Excess nutrients may accumulate to levels that are toxic to plants, potentially influencing aquatic plant growth in rivers, lakes, and estuaries and contribute to a variety of soil- related problems. For example, irrigation water high in sodium and low in calcium and magnesium applied frequently to clay soils can break down soil structure, cause precipitation of organic matter, and reduce permeability. The table below presents the potential for problems at various nutrient levels in irrigation water. Conversion factors and an example for calculating pounds nutrient per acre-foot of irrigation water are provided in the appendix *Conversion Factors and Example for Calculating Pounds Nutrient per Acre-foot of Irrigation Water*.

Summary of Irrigation Water Quality Guidelines. *Source:* Duncan, R. R., Carrow, R. N., & Huck, M. T. (2009).

Water Parameter	Units	Desired Range	Usual Range	Average Domestic	Average Reclaimed
General Water Characteristics					
pH	1-14	6.5-8.4	6.0-8.5	7.7	7.1
Hardness	mg/L	<150	---	---	---
Alkalinity	mg/L	<150	---	---	---
Bicarbonates (HCO_3)	mg/L	<120	<610	174	>194
Carbonates (CO_3)	mg/L	<15	<3	3.0	0
Total Salinity					
ECw	dS/m	0.40-1.20	<3.0	0.8	1.1
TDS	mg/L	256-832	<2000	617	729
Sodium Permeability Hazard					
SARw	meq/L	<6.0	<15	1.9	3.1
RSC	meq/L	<1.25	---	-2.3	-1.88
ECw	dS/m	>0.40	---	---	---
Specific Ion Impact on Root Injury of Foliar Uptake Injury					
Na	mg/L	<70	---	---	---
Cl	mg/L	<70	---	---	---
B	mg/L	<0.50	<2.0	0.17	0.44
Specific Ion Impact on Direct Foliar Injury					

Na	mg/L	<70	---	---	---
Cl	mg/L	<100	---	---	---
HCO_3	mg/L	<90	---	---	---
Selected Nutrients/Elements					
N	mg/L	<10	<2.2	---	---
P	mg/L	<0.1	<0.6	---	---
K	mg/L	<20	<2.0	4.0	26
Ca	mg/L	<100	<400	67	64
Mg	mg/L	<40	<60	24	23
SO_4	mg/L	<90	<960	171	196
Fe	mg/L	<1.00	---	0.16	0.20
Mn	mg/L	<0.20	---	0.01	0.03
Cu	mg/L	<0.20	---	0.04	0.03
Zn	mg/L	<1.0	---	0.012	0.08
Na	mg/L	<120	<920	70	114
Cl	mg/L	<70	<1062	82	130

Salinity

Recycled waters usually contain higher amounts of dissolved salts than other irrigation water sources within a specific geographic region (Harivandi 2007). Water quality analyses may report salinity using a number of parameters, as shown in the appendix *Guidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast*. Dissolved salts in recycled water tend to reduce the number of cation exchange sites, reducing the nutrient holding capacity of the soil. Deflocculation causes the breakdown of clayey soils and reduces the porosity of the soil. Accumulations of salt in the soil are also phytotoxic.

Considerations for irrigation water with higher concentrations of salts (total dissolved salts [TDS] > 500) include irrigation duration and frequency, drainage, and turfgrass species selection. Generally, if the amount of water applied to soil (irrigation and precipitation), exceeds ET, salt movement is downward through the soil profile. Conversely, salts move upward in soils if ET exceeds the amount of water in precipitation or irrigation applied to soil. In the latter case, salt drawn to the soil surface gradually accumulates to levels that are toxic to plants (electrical conductivity [EC] > 3 ds/m). This basic process combined with the type of grass grown determines how severe the problem can potentially become and whether it will ultimately affect the playing quality of the turf. Perennial ryegrass and tall fescue are relatively tolerant to salinity compared to annual bluegrass, bentgrass, and Kentucky bluegrass.

Relative salt tolerance of turf species in NYS. ***Source:*** **Harivandi 2011.**

Sensitive (<3 dS/m)	Moderately Sensitive (3-6 dS/m)	Moderately Tolerant (6-10 dS/m)	Tolerant (>10 dS/m)
Annual Bluegrass	Annual Ryegrass	Perennial Ryegrass	None in NYS
Colonial Bentgrass	Creeping Bentgrass	Tall Fescue	
Hard Fescue	Slender Creeping, Red, and Chewings Fescues		
Kentucky Bluegrass			

Precipitation levels in New York State are generally great enough to naturally flush soils, thereby controlling salinity levels in soils. If precipitation is not enough to flush soils, leaching fractions can be used to calculate the amount of water needed to flush the soil of salts. The formula for calculating the leaching requirement (LR) is as follows:

$$\text{LR} = \frac{EC_w}{5(EC_e) - EC_w}$$

where:
ECw = Electrical Conductivity of Water
ECe = Salt Tolerance of Turfgrass Species

The sodium (Na) concentration and the quantity of other salts in the irrigation water can affect the permeability (the ability of water to infiltrate into the soil and move through the profile) in clay soil. When irrigation water has Na levels > 200 mg L^{-1} , Na may build up over time and affect permeability. Calcium, which is important to soil structure stability, is displaced by sodium, which in turn causes the soil structure to break down, and results in reduced water and oxygen infiltration and percolation. This problem can become a more serious problem on fine-texture clayey soils than sand-based systems (see Table E in the Appendix *Guidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast*).

Residual sodium carbonate (RSC) values are used to assess the sodium permeability hazard. RSC is a measure of the influence of bicarbonates and carbonates as compared to the calcium and magnesium concentration. The total salt content of the water (EC) and the sodium adsorption ratio (SAR) must be considered together when determining irrigation water restrictions due to the sodium permeability hazard. RSC levels below 1.25 meq/L are safe to use for irrigation.

Irrigation water restrictions related to soil water infiltration. ***Source:*** **Harivandi 2011.**

SAR	None	Slight to Moderate	Severe
	EC (mmhos/cm)		
0-3	>0.7	0.7-0.2	<0.2

3-6	>1.2	1.2-0.3	<0.3
6-12	>1.9	1.9-0.5	<0.5
12-20	>2.9	2.9-1.3	<1.3
20-40	>5.0	5.0-2.9	<2.9

Irrigation Water Requirements

Seasonal and bulk water requirement analysis can be conducted to determine water requirements. The seasonal bulk water requirement analysis verifies the suitability of a water source and irrigation system to supply irrigation water under normal conditions. The maximum seasonal bulk water requirement analysis is a worst-case scenario estimate to simulate extended drought conditions, calculated by not allowing for effective rainfall. The National Climate Data Center (NCDC) provides historical climate data as far back as 1895 as well as statistics on precipitation across ten regions in New York. The NCDC uses Palmer Indices, which summarize data for precipitation, evapotranspiration, and runoff, which can be used to calculate the average number of weeks in a statistical year with a water deficit, the average values of the deficits, and the peak evapotranspiration losses assuming no precipitation.

For more information, see:

- NCDC data: http://www.ncdc.noaa.gov/
- Calculating water requirements: Chapter 3, “Environmental Best Management Practices for Virginia’s Golf Courses” at http://www2.cybergolf.com/sites/images/373/Virginia-BMP-Full-Report-final.pdf.