Executive Summary

WERF

Should we use recycled water to irrigate turfgrass?

Attenuation of PPCPs Through Golf Courses Using Recycled Water (WERF1C08)

The Central Issue

Landscape irrigation with recycled water (i.e., reclaimed/reused water, treated wastewater, tertiary treated effluent) has become a viable and beneficial practice and is seen as an essential aspect of water supply planning in many areas. Large communities in the arid southwest (e.g., Las Vegas, Los Angeles, and Phoenix) use a significant amount of their potable water supply to irrigate urban landscapes. Other parts of the country are increasingly doing the same. Turfgrass, including golf courses, parks, and median strips, is the single most important landscape type.

Beyond the availability and cost considerations, is the issue of the fate and transport of the chemicals that are present in that recycled water. Conventional wastewater treatment removes some or most of the pharmaceutical and personal care product (PPCP) chemicals, but there are residuals in the recycled water that end up on turfgrass or that are discharged into lakes, rivers, and estuaries. This study was conducted to better understand the fate and transport of PPCPs in turfgrass/soil systems when recycled water was used as the sole source of irrigation water. These PPCP compounds are pharmaceuticals that are taken orally, or they are personal care product chemicals that are intended to be placed on the skin or for some are intended for oral use (for example, in toothpaste). Their presence in groundwater or surface water, should it occur, in these low amounts does not suggest a cause for health concerns. The results of this research support the use of recycled water for turf irrigation purposes, as long as sound irrigation management practices are implemented.

Context and Background

This research builds on earlier published work by other investigators that reported preliminary data showing that turfgrass/soil systems can be highly effective in removing the majority of PPCPs from recycled water (Snyder et al., 2004). WERF has invested in research to better understand and improve the treatment – that is the removal – of PPCPs. Research has focused on both conventional and advanced wastewater treatment systems and on dozens of PPCPs including those considered to be indicators or surrogates of the hundreds of PPCPs in everyday societal use.

Findings and Conclusions

There was agreement in the findings for the lysimeter, field plot, and golf course experiments. All demonstrated that turfgrass has a considerable capacity to attenuate PPCPs introduced to the root zone (the top one foot of a turfgrass/soil system) by irrigation with recycled water. The mass of all the PPCP chemicals were significantly reduced as they passed through the root zone and into deeper soil. The research showed that PPCPs mass flux needs to be calculated because the mass flux represents the actual compound load leaving the root zone and moving into deeper soil. Measurement of concentration alone would not provide useful information. The implications of a PPCP measured at a relatively high concentration in soil water would be quite different under low-water flux versus high-water flux conditions.

Table ES-2 in the report depicts the level of removal for each of the 15 compounds across various combinations of conditions in the field plot and lysimeter studies. For the vast majority of conditions, the PPCPs removal was 98% – meaning only 2% or less of the compound moved beyond a depth of three to four feet. Recall the root zone is typically about one foot. The lowest measured removal, between 80% and 84%, was for two of the PPCPs under high irrigation in sandy soil.

The same several compounds leached in all three test systems. The amount of the PPCP compounds that were found in the drainage water was low – generally less than 5% of the mass in the irrigation water. The "release rates" ranged from 5-120 milligrams (mg) of chemical per acre per year. To put that in context, a single typical dose of aspirin is 325 mg. So for the PPCP with the highest leaching in this study, 120 mg would be released below the root zone. This is roughly equivalent to about a third of an aspirin tablet spread over an acre during the course of one year.

Related WERF Research

Project Title	Research Focus
Fate of Pharmaceuticals and Personal Care Products through Municipal Wastewater Treatment Processes (03CTS22UR)	Looked at "indicator" compounds as a way to support the prediction for removals of PPCP compounds for which there are no reliable analytical methods and/or the compounds are present at extremely low concentrations. Monitored removal of many of the same compounds at full-scale secondary treatment facilities of differing types. Key findings: ■ Many of the compounds are consistently removed at 80% or better in systems with a solid retention time (SRT) of 5-15 days. ■ Media filtration did little to remove PPCPs. ■ Reverse osmosis was very effective in removing the PPCPs. ■ Chlorine disinfection, ozonation, and ozone/hydrogen peroxide provided some additional removal, but chloramine and UV light alone did not. ■ Separating the PPCPs into treatment bins based on measured removal efficiency as being good, moderate, or poor provides a tool to help operators select indicator compounds for local monitoring efforts.
Development of Indicators and Surrogates for Chemical Contaminant Removal during Wastewater Treatment and Reclamation (04HHE1CO)	
Contributions of Household Chemicals to Sewage and Their Relevance to Municipal Wastewater Systems and the Environment (03CTS21UR)	
Performance Dynamics of Trace Organic Chemicals in Onsite Treatment Units and Systems (DEC14U06)	Full-scale septic tank and sequence batch membrane bioreactors serving 400 housing units effectively decreased chemical concentrations, often below detection limits. The soil portion of a septic system proved effective at removing most readily degradable chemicals.
Trace Organic Compound Removal during Wastewater Treatment (CEC4R08)	Multi-faceted effort intended to answer: ■ What compounds should be best monitored to assess performance? ■ How does process operation affect trace organic chemical removal? ■ Can we model predict PPCP removal at a WWTP?
Demonstrating Advanced Oxidation Technologies on Pharmaceutical Removal Downstream of Biological Treatment (INFR6SG09)	Focused on carbamazepine (a frequently found and recalcitrant PPCP in conventional wastewater treatment) that was removed to a lesser extent in the root zone during irrigation with recycled water. However, UV light in combination with hydrogen peroxide produced breakdown products that could then be completely biodegraded. This advanced treatment holds promise for other ring-bearing compounds.
Demonstrating Advanced Oxidation/Biofiltration for Pharmaceutical Removal in Wastewater (U2R11)	This follow-on study evaluates the effectiveness of UV-based advanced oxidation to remove recalcitrant pharmaceuticals in wastewater.
Developing a Standardized Protocol for Assessing the (Treatment Plant) Biodegradability of Trace Organic Contaminants (U3R10)	Establishes a method and protocol to assess the biokinetics of PPCP compounds and then validate the methodology through experimentation at full-scale WWTPs. Provides a standard approach for site-specific evaluations of PPCP removal.
Trace Organics in Biosolids Challenge	Will provide necessary environmental fate and human and ecological effects data to inform the risk assessment efforts underway at U.S. EPA for compounds that have been reported in the National Sludge Survey. While the focus of this program is on compounds that are in biosolids applied to soil, the same or similar environmental fate and effects information is relevant to recycled water applied to turf/soil systems.

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- The research shows that the root zone provides considerable removal of representative pharmaceuticals and personal care product (PPCP) compounds in recycled water used for irrigation of urban landscape. The removals were 80% or more through the root zone for the 15 compounds studied in this project.
- Water flux (or flow rates) through the soil profile is an essential aspect, along with the concentration of a chemical in soil water, of predicting the fate of PPCPs in recycled water used for turfgrass irrigation.
- The results support the use of recycled water for turf irrigation purposes, as long as sound irrigation management practices (e.g., cycle and soak irrigation and avoidance of over-irrigating especially in sandy soils) are implemented.
- Urban turfgrass including golf courses provides a suitable location for recycled water application.

Management and Policy Implications

Facilities that use recycled water should understand water quality issues related to recycled water such as high salts, additional nutrients, and others. These issues play a major factor in how turf managers can strategically apply recycled water as irrigation to golf courses or large landscaped areas. Factors such as soil type, turf type, and evapotranspiration rate also determine how much water is applied to the turf. For golf courses using recycled water, playing conditions are an integral part of water management.

Golf courses irrigating with recycled water should use a leaching fraction as a tool to aid in addressing excessive salts in recycled water. Course managers should avoid over irrigating with recycled water in sandy soils where less sorptive, more slowly degraded compounds could move through the root soil and soil profile into shallow groundwater.

Recycled water will reduce the use of potable or groundwater supplies for irrigating large outdoor landscapes.

For a compound that is removed 80% in conventional wastewater treatment and then a further 80% in the root zone, the combined removal is 96%. 80% removal in wastewater treatment is achievable for many PPCP compounds, particularly when the solids retention time can be increased beyond 5-10 days. For a compound removed only 50% in conventional wastewater treatment, and then 80% or more in the root zone, the combined removal is 90% or more.

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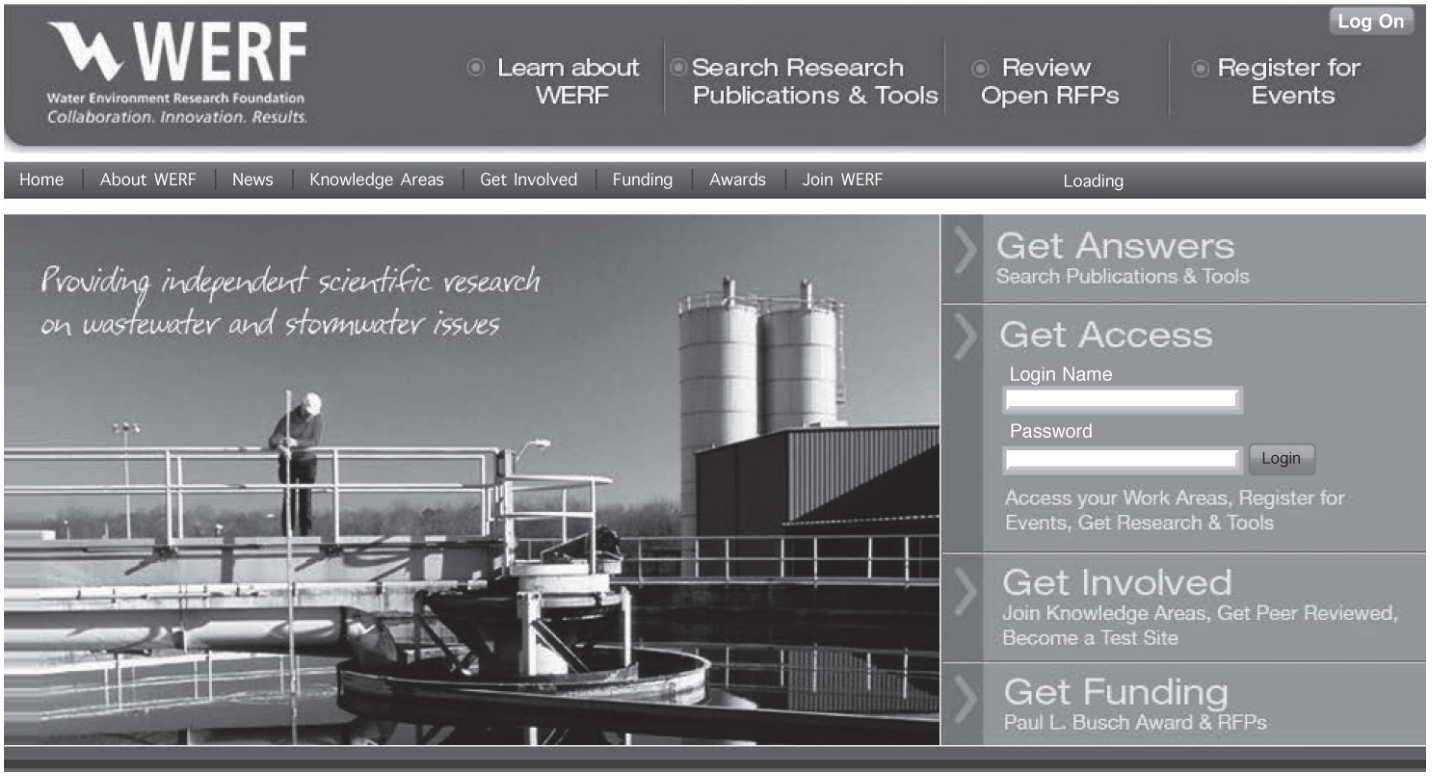

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