WATER REUSE IN NEW JERSEY

Fred R. Gaines, P.E., DEE and Zach Gallagher

Water, water, everywhere,
And all the boards did shrink;
Water, water, everywhere,
Nor any drop to drink.
From the Rime of the Ancient Mariner by Samuel Taylor Coleridge

Contrary to what the people of the Northeastern United States may believe, at times there is a limited supply of potable water. This document will present some background information on the requirements for a policy developed in New Jersey to encourage and control water reuse; discuss the minimum criteria for reuse; present some technical alternatives that will achieve these criteria, and demonstrate some examples of projects where reuse has been achieved. It is based upon the New Jersey Department of Environmental Protection (DEP) Technical Manual for Reclaimed Water for Beneficial Reuse (RWBR) published in 2003.

Background: One of the impacts of the Northeast Drought of 1999 was that, even in a water-rich State like New Jersey, citizens were made aware of the value of water as a resource. Following the drought various entities elected to evaluate the options of reusing treated wastewater on a permanent basis. As a result, the State of New Jersey passed N.J.A.C. 7:14A-2.1, a law that established responsibility for the DEP to encourage and promote RWBR along with water conservation. To assist both municipal and private wastewater facilities in complying with the regulations, the DEP then issued a Technical Manual in January of 2003. Following comments and suggested revisions, the agency has issued an updated 2005 version which includes guidelines for the preparation of reuse feasibility studies.

RWBR consists of taking water that was once considered a waste product, treating it to specialized level of treatment and using the resultant high-quality reclaimed water for beneficial reuse. The final application of the reclaimed water determines the amount of treatment that is ultimately provided. Typical examples of reuse applications are:

- Toilet and Urinal Flushing
- Landscape Irrigation
- Agricultural Irrigation
- Industrial Applications (cooling water, boiler make-up water, etc.)
- Fire Protection
- Aesthetic Fountains and Lagoons
- Construction Applications (dust control, concrete production, etc.)
- Environmental & Recreation
- Groundwater Recharge
- Miscellaneous (vehicle washing, laundry facilities, etc.)

The quality of the water after treatment is generally determined by its end use. As a result, water that is more likely to come in contact with human beings (Category 1 RWBR – Public Access Systems) is usually subjected to higher levels of treatment.

Effluent Criteria: The minimum effluent treatment requirements take into consideration the fact that the application of reclaimed wastewater cannot compromise public health. Other requirements such as avoiding public nuisances, preventing environmental degradation, aesthetics and public acceptability must also be considered; however, public health remains the most critical element.

An adverse public health impact may be caused by either harmful biological or chemical constituents that have not been removed from the wastewater. In order for water to be acceptable for reuse, it must be free of pathogenic bacteria, parasites and enteric viruses. In addition, the levels of toxic chemicals must be reduced to a safe level.

In general, conventional wastewater technology must be supplemented with more advanced technology in order for the low levels of contaminants required by RWBR to be socially acceptable. In some cases, effluent from an existing treatment plant may be used by industry with no further treatment. The DEP has established the following discharge criteria, depending upon the end use of the reclaimed wastewater:

2003 Reclaimed Water for Beneficial Reuse Criteria

Reclamation Category **Unit Operation**	**I** **Public Access**	**II** **Restricted Access and Non-Edible Crops**	**III** **Agricultural Edible Crops**	**IV** **Industrial Systems O & M and Construction**
Minimum Design Flow*	0.10 MGD	0.10 MGD	0.10 MGD	0.10 MGD
Spray Irrigation		Geometric mean value of fecal coliform shall be <200 fecal coliform units per 100 mL. Any one sample shall not be > 400 fecal coliform units per 100 mL. If UV is used, a dose of 75 mJ/cm^3 must be used.	Only allowed if crops shall be peeled, skinned, cooked or thermally processed.	
Disinfection	Total chlorine residual of at least 1.0 mg/L, or UV dose of 100mJ/cm^2	Facility to establish a standard operating procedure		
Fecal Coliform	< 14 fecal coliforms per 100 mL. (Instantaneous max) / < 2.2 fecal coliforms per 100 mL. (7 day median)			
TSS	< 5.0 mg/L before disinfection. Continuous monitoring for turbidity is required.			
Total Nitrogen	< 10.0 mg/L	< 10.0 mg/L		
Loading rate	< 2.0 inches per week	< 2.0 inches per week		
Other		May not graze dairy cows for 15 days after application.	1. Use application method 2. Must submit an inventory of crops to DEP. 3. Must meet Category 1 criteria	Case-by-case review by the DEP.

*** According to DEP staff, "a design capacity of 0.1 MGD will not be required as long as an operator is on call 24 hours per day and it is shown that the facility can operate automatically with alarms should any problems occur"**

Treatment Technology: Although conventional wastewater technology may meet the minimum criteria established for category IV (industrial applications) some industrial applications may require more stringent treatment. It is likely that additional technology will be required to ensure consistent compliance with the more stringent regulations for Categories I, II and III. These techniques may include the application of one or more of the following technologies:

- **Flow Equalization** – The application of flow equalization enhances both the biological and chemical wastewater treatment processes.
- **More Efficient Biological Treatment** – Conventional Complete Mixed Activated Sludge is improved by sub-systems that allow for increasing the efficiency of the biological process. These systems include Rotating Biological Contactors (RBCs), Sequencing Batch Reactors (SBRs), Moving Bed Biofilters (MBBRs) and Membrane Bioreactors (MBRs). In addition, thermophillic and anaerobic processes may be used for high organic wastewater treatment.
- **Advanced Wastewater Treatment** – Processes that incorporate Biological Nutrient Removal (BNR) such as the South African BardenPho process have proven effective for removal of nutrients such as phosphorous and nitrogen.
    - Phosphorous Removal – Phosphorous occurs in sanitary wastewater as a byproduct of digestion as well as being present in household detergents. In the aquatic environment, Phosphorous supports the growth of algae and other plants that enhance the eutrophication or clogging of lakes, streams and other receiving waters.
    - Nitrification – Nitrogen generally enters the treatment facility as urea. It breaks down rapidly to ammonia form nitrogen (NH_3-N) and consumes the oxygen in a treatment plant or receiving water. Under proper conditions in a conventional treatment facility, naturally occurring bacteria will convert the (NH_3-N) nitrogen to nitrites (NO_2-N) and then to nitrates (NO_3-N), a more stable form. Nitrates in water are considered toxic to infants, replacing oxygen in their blood stream and causing "blue babies." Nitrates also speed the formation of certain oxygen-consuming algae species, including the "red-tides" that cause major fish kills.
    - Denitirification – This is a process that utilizes anoxic (oxygen-starved) microorganisms along with a carbon source to reduce the nitrates to harmless nitrogen gas.

- **Effluent Filtration** – One technology that is being applied extensively in the wastewater field is the application of filtration of the treated effluent. Filtration systems may use cloth, sand or synthetic material of membranes as media. By removing particles down to the colloidal range, some filters will also remove waterborne viruses and bacteria.
- **Membrane Treatment** – One of the major advances that have seen expanded application in the last few years is that of membrane technology.

- Membrane Filtration - The simplest form of membrane application is to use these devices as high-efficiency filters. The membrane pore size is small enough that water borne contaminants such as coliform organisms, and the two most common pathogens, *Cryptosperidium* and *Giardia,* cannot pass through them.
- Membrane Bio-Reactor (MBR) – This system uses the membrane as a “secondary clarifier,” retaining a concentrated biomass in an aerobic reactor to metabolize organic material and nutrients. The small pores prevent carry over of the biological floc significantly improving the efficiency of the process.
- Reverse Osmosis (RO) – This process incorporates the application of a special membrane and differential pressure to separate the salts from the liquid that they are dissolved in. The process produces ultra-pure water.

- **Color Removal** – One of the issues with the application of reused water may be the presence of color. Color bodies are removed by filtering the effluent through activated carbon for adsorption, or by bleaching with chlorine or ozone.
- **Disinfection** - The application of chlorine as a disinfectant may not be applicable in some reuse applications since the resultant chlorides or chloramines can be harmful. The application of ultra-violet technology is especially efficient. The water streams being disinfected are virtually free of suspended or colloidal solids and turbidity that would reduce its effectiveness.

The availability and effectiveness of this new and improved technology and modern materials of construction have made the process of reclamation of water for beneficial reuse technically feasible, economically viable and politically acceptable.