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Studies

OPTIMIZATION MODEL FOR ON-SITE RESIDENTIAL WASTEWATER TREATMENT AND RECYCLING

A thesis submitted toward the degree of
Master of Science in Environmental Engineering

by

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This research was carried out in the Environmental Engineering Program
Under the supervision of Prof. Abraham Kribus and Prof. Mordechay Sokolov

September 2005

Abstract

Water treatment and recycling is essential in arid and semi arid regions where the availability of freshwater is not sufficient to provide the entire demand. Water treatment is usually done on a municipal or regional scale, and the effluents are used for irrigation or released into the environment. The Residential Water Treatment and Recycling (REWATR) approach proposes a different method: localized reclamation and use of water. The wastewater from a group of residential units (for example, 40 apartments in building) is collected to a neighborhood treatment plant and treated on site. The effluent is recycled back to the same residential units rather than sent to distant agricultural areas.

The REWATR approach is implemented by separating the residential water system into two drain circuits, namely: Gray water (sinks, shower and laundry drain water) and Black water (toilet flush), each collected, treated and recycled. The amount of contaminants in Gray Water is low, and therefore its treatment is relatively easy. Its treated effluent is returned to the residence for non-potable uses such as toilet flushing. The second drain circuit of Black Water collected from the toilets may be either sent to the municipal sewer, or to a second local treatment plant. The effluent from the local Black Water Treatment plant can be used for garden irrigation or other applications where low-quality water is permitted. The impact of the REWATR approach can be a saving of up to 40% in the amount of freshwater consumed and in the sewage load disposed into the municipal system.

The goal of this research was to evaluate the technological and economical feasibility of this approach, as well as other aspects such as health and safety. To accomplish the aforementioned, a mathematical model was developed and a dedicated computer code was written that includes an Optimization unit that seeks the sizing of a system which will be economically most beneficial, and a Simulation unit that simulates the system performance at each instant. The final outcome is an evaluation of performance and cost of a REWATR system.

Several typical situations were analyzed and evaluated using the model, showing the potential saving in water consumption, and the estimated additional expense or saving of such a system. For a city block (400 apartments) the REWATR is already cost-effective; return on the investment period is ten years. For a single building (40 apartments), profitability is possible either if water cost is raised by 13% or if interest for environmental investments is subsidized.