WAWTTAR

A planning tool for selecting wastewater treatment technologies

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Significant progress has been made during the last 30 years to improve the effluent quality of municipal wastewater treatment systems. Virtually all older facilities have been significantly upgraded, and most systems constructed since the early 1970s have implemented treatment technologies that produce an effluent quality significantly higher than was the norm prior to the passage of the Clean Water Act. However, during the last 5 to 10 years, numerous systems either built or upgraded prior to 1985 have again required upgrading to meet more-stringent discharge limitations and increased loadings. In addition, many new treatment facilities have been constructed in rural communities with wastewater collection systems.

Most large communities have sufficient economic and technical resources to ensure that the new facility planning process adequately matches their needs with the wide range of available treatment technologies. Smaller communities however, frequently lack either the economic resources or technical expertise to support a facility planning process that examines the broadest range of appropriate treatment technologies. Frequently, the consultants, public works staff, and community decision-makers have training or experience with only a limited range of "conventional" treatment technologies, and the facility planning process fails to consider a wide range of potentially applicable alternative technologies. The selection of inappropriate technologies often results in facilities that perform poorly and fall into disrepair due to a lack of basic resources, such as spare parts, operations and maintenance personnel, and technical expertise.

However, a free, easily accessible, and evolving computer-based tool exists to help ensure that all possible treatment options are considered. The Water and Wastewater Treatment Technologies Appropriate for Reuse (WAWTTAR) model is a prefeasibility planning tool intended to assist planners in selecting suitable water and wastewater treatment options appropriate to the material and manpower resources available to particular communities throughout the world. WAWTTAR can estimate the localized performance and cost of many possible systems for any location and condition with basic information on the problem to be solved. WAWTTAR is designed to assist in alleviating the problem of overlooking good processes and help screen out treatment technologies that are inappropriate for particular locations and situations.

What Is WAWTTAR?

WAWTTAR is a tool to assist in the planning and implementation of wastewater treatment systems, including treatment systems incorporating wastewater reuse. The program was designed to be used at the prefeasibility step in facility planning and infrastructure investment. The program has a database of more than 200 centralized and onsite water and wastewater treatment processes and is user-expandable. The database of processes includes information on removal efficiencies, resource requirements, basis for design, color photographs, line drawings, and referenced text files. WAWTTAR can formulate a wide range of treatment trains and estimate the costs needed to build and oper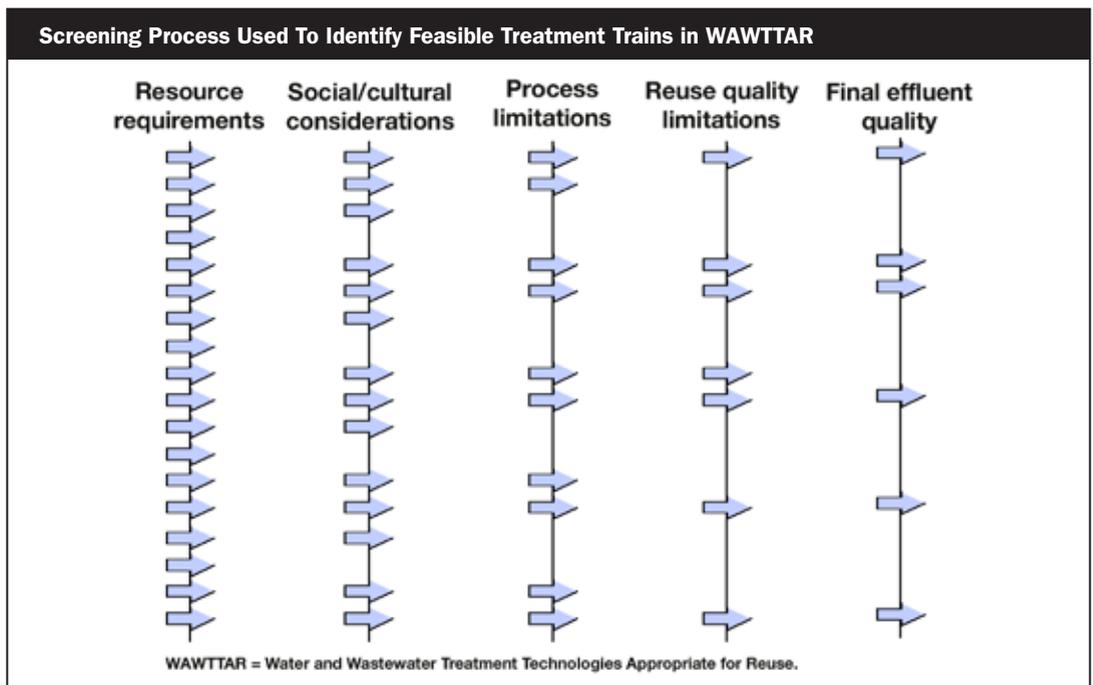ate them. WAWTTAR was developed as part of a project associated with the 1993 Middle East Peace Talks and was funded by the U.S. Agency for International Development. WAWTTAR has been expanded and revised numerous times, most recently in 2005 as part of a project funded by the U.S. Environmental Protection Agency.

The target audience for WAWTTAR is local engineers and planners (with water or wastewater treatment training) doing community water or wastewater feasibility or facility planning; government or nongovernmental engineers performing evaluations of consultant or donor proposals; and technical students, engineers, planners, and government decision-makers looking for an educational resource addressing water and wastewater treatment processes. Versions of the program have been under development and in use for 16 years.

WAWTTAR's main use is as a tool to screen and research possible water and wastewater treatment options. It is intended to help planners improve their strategies for water and wastewater treatment in any location and under local conditions. It will not choose the "best" possible option for a specific situation — this can only be done by using solid engineering judgment. However, it can be used to evaluate many more systems on the basis of performance and cost-effectiveness than ordinarily would be possible. WAWTTAR, therefore, facilitates selection of sensible options.

How Do I Use WAWTTAR?

A typical WAWTTAR user would begin by selecting an appropriate discharge standard,

Screening Process Used To Identify Feasible Treatment Trains in WAWTTAR

Resource requirements — Social/cultural considerations — Process limitations — Reuse quality limitations — Final effluent quality

WAWTTAR = Water and Wastewater Treatment Technologies Appropriate for Reuse.

entering information about the community of interest, and assembling a collection of treatment trains containing a wide assortment of treatment processes. WAWTTAR comes with a collection of U.S. and international potable and wastewater discharge and reuse standards. Each standard can specify a minimum and maximum concentration for any of nearly 100 water quality constituents. New or modified standards can be entered by the user if no existing standard in the WAWTTAR list is appropriate for the problem under consideration.

An editing tool is used to describe the characteristics of the community under consideration. These include water demand, wastewater characteristics, resource cost and availability, the presence or absence of institutional support, financial and population characteristics, and various community cultural factors that might affect the choice of an appropriate wastewater treatment technology.

Resources in this case include the type and reliability of the power supply, manpower (from simple unskilled labor to technical and professional personnel), the availability of treatment chemicals, and any other type of human or physical capital that might be necessary.

The user creates an array of treatment trains that WAWTTAR will compare against one another and against the community profile and discharge requirements. The treatment trains represent logical assemblies of processes to treat water or wastewater. While a number of treatment trains are preassembled, an editing tool makes it easy for users to construct new trains or modify existing trains that might be worthy of consideration for the problem under study. The train editing tool guides the user through the process of selecting from a list of preliminary, primary, secondary, tertiary, and solids treatment processes. While more than 200 treatment processes are available in the WAWTTAR database, users can enter a new process or edit an existing one.

WAWTTAR uses a curve fit of land requirements, construction costs, and operation and maintenance (O&M) costs, and performance versus process loading (hydraulic, organic, or solids) to perform calculations. Cost breakdowns are used to localize construction and O&M costs for a particular community. The construction cost for each process is divided into categories of labor, earthwork, manufactured equipment, structures, concrete, steel, and pipes, valves, and instruments. O&M cost categories are labor, chemicals, materials, and energy and land requirements.

Information on treatment processes can come from U.S. Environmental Protection Agency documents, technical reports, manufacturers, and practical experience as developed or reported by private and public agencies. In addition to the technical data described above, sufficient reference material (text, photos, line drawings) is provided for each process so that WAWTTAR can serve as an educational tool for engineers and community planners.

Once the user has defined the community of interest and selected a reuse objective (if any) and a discharge standard, WAWTTAR will perform a screening process to identify feasible treatments as those that satisfy the community, technological, and regulatory constraints for the problem. Infeasible treatment trains are identified, along with the reason that they were classified as infeasible. Estimated capital and operating costs over the project planning period are computed for all feasible trains, along with subjective measures of adaptability of the train to varying hydraulic and mass loadings, and the ease of future upgrades.

What Does WAWTTAR Give Me?

The output from WAWTTAR is broken into two text files: the Feasible Solution File and the Infeasible Solution File.

The Feasible Solution File contains information detailing the cost and performance of feasible treatment trains. This file contains the general design criteria for the problem, followed by a detailed accounting of capital cost, O&M cost, land requirements, and land cost for each process in each feasible train. The total cost for the train, total per capita cost, and total cost per dwelling for each treatment train also are supplied. All costs are reported based on a user-specified choice of annual or total project costs.

WAWTTAR also provides an adaptability index, which ranges from zero to 3, and rates how easily each train can be upgraded and handle variations in hydraulic loading and influent quality.

Final effluent quality for each of up to 10 user-specified water quality constituents, along with potential social and environmental impacts, is reported for each train. WAWTTAR also presents the trains in a table that is ranked by multiple parameters. Users can specify rank criteria of minimum capital cost, minimum O&M cost, or minimum total project cost.

The Infeasible Solution File contains the details on any treatment train that fails the screening criteria established by the user, as well as information on which screening criteria were not met. Frequently, review of why a train was classified as infeasible yields important insights into the current problem and design process. Therefore, users are encouraged

to examine the Infeasible Solution File and potentially re-evaluate problem specifications.

Who Uses WAWTTAR?

While WAWTTAR's initial target audience was outside the United States, it has also found considerable utility by engineers involved in small-community project planning in the United States. WAWTTAR also has been widely praised as a valuable educational tool for engineers and facility planners.

WAWTTAR has been used in a wide range of community locations and settings, including Jamaica (semirural setting); Bulgaria (municipal–industrial setting); the West Bank and Gaza (municipal and peri-urban setting) in the Middle East; Koror (Palau), Brazil; two small communities in Hawaii; and several small to medium-size communities in California, Oregon, Washington, Idaho, and Arizona. Validation exercises to date have shown that the program is sensitive to the range of environmental, economic, and social conditions considered in the program design.

WAWTTAR has assisted in the evaluation of a variety of infrastructure investment scenarios in the areas of water treatment, wastewater treatment, and water reclamation. For example, in the West Bank and Gaza, WAWTTAR was used to evaluate the long-term sustainability of a specified wastewater treatment technology promoted by a potential donor. While the technology might be a fine choice in some settings, the lack of trained operational staff and the inability to easily obtain spare parts resulted in a decision that the potential donation would not provide a sustainable solution to the wastewater treatment needs of the community.

In some cases, rather than specifying a particular technology, a donor or government agency may specify a specific financial limit on a project. WAWTTAR can be helpful in these situations by enabling a rapid examination of the costs and resource requirements of various treatment alternatives.

In an application in Jamaica, WAWTTAR helped determine which treatment technologies allowed for the largest service area in a semirural region with a fixed budget. WAWTTAR also evaluated which technologies minimized the risk of system failure by considering limits on resources, labor, materials, management, and technology that are unique to the area.

In the United States, the most common use for WAWTTAR is to determine the least-cost (total construction and O&M) treatment system that meets a community's needs and is compatible with its socioeconomic conditions. For example, WAWTTAR has been used to assist in the feasibility and facility planning process for new treatment facilities in Laie,

Hawaii; and Willits, California. In both of these small communities, the treatment facilities were failing and completely new treatment facilities were to be designed by local consulting firms. WAWTTAR was instrumental in pointing out possible treatment processes that the consulting engineers initially had not considered.

WAWTTAR also can be used to identify treatment technologies that can be used to upgrade a facility to meet new discharge requirements or water reuse standards. For example, WAWTTAR was used to identify constructed wetlands as a least-cost upgrade to an oxidation pond system to meet new discharge requirements for the city of Garberville, Calif.

Where Can I Find WAWTTAR?

The program, which runs under the Windows operating system, and a detailed user manual are available from the WAWTTAR Web site at http://firehole.humboldt.edu/wawttar.

The Web site also has a forum where users can exchange questions and comments. The original intent was that, over time, users would provide updated cost and performance information, which would be used to update the WAWTTAR process database. Unfortunately, most consulting firms and equipment vendors have been reluctant to provide data to be used in WAWTTAR, fearing they will lose some perceived competitive advantage over other firms.

Since the last update to WAWTTAR in 2005, sharing new process data has been simplified to help encourage user participation. A simple menu selection enables any user to upload data to the Web site for a new or revised treatment. After review, the new data are available for any WAWTTAR user to download by selecting the appropriate menu choice in the program.

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