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# UTILIZATION OF SMALL SYSTEMS TREATMENT IN LATIN AMERICA AND CHINA

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## Background

In his State of the Union speech on February 17, 1993, President Clinton outlined a new technology initiative to accelerate environmental protection while strengthening America's industrial base. This initiative was given the title of Environmental Technology Initiative (ETI). Its goal was to develop more advanced environmental systems and treatment techniques that could yield environmental benefits and increase exports of "green" technologies. One of the components of ETI is the U.S. Technology for International Environmental Solutions (U.S.TIES) program. This program was designed to enlist greater participation of the U.S. private sector in achieving U.S. environmental objectives overseas. This public-private partnership supports environmental projects in a number of areas, including: international technical assistance and training, information dissemination, financial assistance, technology demonstrations, and the international adoption of regulations and standards.

While U.S.TIES was first proposed shortly after the Earth Summit in Rio de Janeiro, the concept of a public-private partnership on behalf of the global environment was further emphasized in a number of Presidential and Congressional mandates. Congress, in appropriating funds for ETI, specified that the primary objective should be the development and employment of environmental technologies to enhance the environmental security and the economic standing of the U.S. in the world market place. U.S.TIES is aimed at assuring that American innovators, manufacturers, service suppliers, and workers play a major role in the improvement of the world's environment through the provision of their goods and services. Funding for this initiative consisted of: $36 million for ETI and $8 million for U.S.TIES in fiscal year 1994; $48 million for ETI and $12 million for U.S.TIES in fiscal year 1995; and proposed for fiscal year 1996 is $10 million for ETI that has been specified for technology verification.

## Introduction

Three drinking water projects have been initiated by the Environmental Protection Agency's Water Supply and Water Resources Division, National Risk Management Research Laboratory, Cincinnati, Ohio. These projects were selected for countries where it appeared that the greatest potential for success and creation of a market for U.S. products would occur. For fiscal year 1994, two projects were funded. One is located in Ecuador and the other one is in Mexico. For fiscal year 1995, a project was funded for China. Each of these countries have similar types of drinking water concerns with problems that are also unique to their country. Below is a description of the demonstration sites and the treatment that will be used at these sites as known at this time.

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## Demonstrations

### ECUADOR

Under an interagency agreement with the U.S. Agency for International Development (U.S.AID), a solicitation was published seeking U.S. companies interested in demonstrating their drinking water treatment technology in Ecuador. The intent of this project is to provide safe drinking water at selected sites in Ecuador using technology that can be operated and maintained at a reasonable cost. Demonstration of this technology is expected to open up markets in South America. During a visit in May, 1995, three demonstration sites were identified where a need exists and there is a willingness to participate and cooperate. Sixteen proposals were received by the project's consultant and World Water Systems, Inc. of Colorado Springs, Colorado was selected to provide specific technologies for each site identified below.

- Hospital Rodriguez Zambrano in Manta - The existing water system at the hospital consists of a two inch diameter line which goes into two 66,000 gallon tanks. Chlorination is done in these tanks by the addition of liquid chlorine (Chlorox). Aeration is used to mix the liquid chlorine. A swimming pool-type color comparator is used to monitor the chlorine residual. Immediately after chlorine addition, high residual levels are detected which quickly dissipate to non-detectable levels.

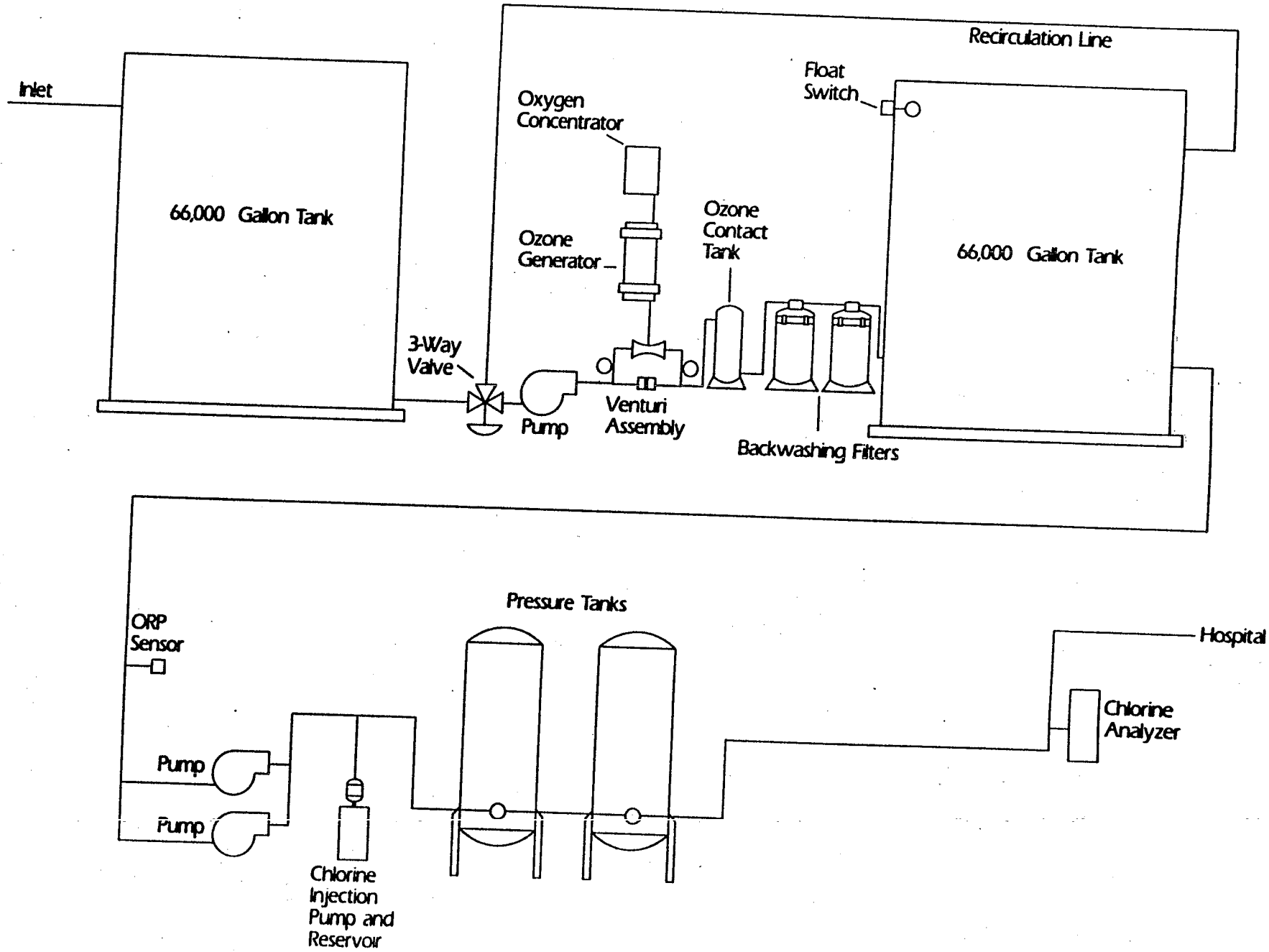
Water from the tanks is pumped by three 20 HP pumps through a four inch diameter pipe and distributed with a 60 psi pressure system. Water usage at the hospital is variable with a maximum of 26,000 gal/day. The hospital has 220 beds with an average of 8,672 patients/year and 594 employees. The number one morbid disease in Manta is diarrhea. The number one mortal disease is malnutrition and the fifth is diarrhea.

Modification of treatment will consist of using one of the existing 66 gallon tanks for raw water accumulation and storage. The second tank will be used for storage of disinfected water. An ozone system will be located between the two tanks with ozone inducted to the raw water supply as it flows from one tank to the other. Two backwashing filters containing sand, anthracite, and garnet media will be used for particle removal prior to the second tank. Chlorine will be injected prior to entering two existing pressure tanks (Figure 1).

- Monteoscuro - This community has 150 families with 120 connected to a water system served by a well. The well is one year old and the water is described as salty. There is a 13,000 gallon storage tank 3,800 yards from the well. This community has a state-supported medical center that has been in operation since 1984. Diarrhea is very common among the families who are members of the clinic and good records are kept on these families.

The water supply at Monteoscuro contains a significant particulate load that has to be reduced. This will be accomplished by using a manual backwashing filter containing sand, anthracite, and garnet media. After filtration, primary disinfection of the water supply will be done by using a Teflon coil UV unit.

# Figure 1. Hospital Rodriguez Zambrano Treatment System



The UV unit will be located at the protected wellhead area and powered from the same source as the existing pump, thus ensuring that when electricity is available to pump water from the well to the existing storage tank, it is also available for the UV unit. Post-disinfection with chlorine will provide a residual in the distribution system (Figure 2).

A majority (60% to 70%) of the Monteoscuro residents currently boil their water for disinfection. Propane fuel is used at a cost of approximately $1.20 per household every three weeks. This amounts to about $20.80 per household per year. Assuming there are 78 households (120 households times 65%) that boil their water, the total costs to the community per year is $1,622.40. One might think that the use of UV is an expensive alternative. By using the above information and assuming that eight UV bulbs costing $50 per bulb is used and assuming that the average bulb life is one year, the annual UV bulb replacement costs will not exceed $400 for the community. Also, electrical consumption will be low; about the equivalent of eight 40 watt light bulbs. Therefore, by using UV, disinfection cost should be reduced by over 50%.

- La America - This community receives spring water from about 1,600 feet uphill from a 15,000 gallon storage tank. The tank is cleaned every two months. There are 56 homes connected to the system. A typical family uses 110 gallons per day. They find a yellow slime on the bottom of their home storage tanks when the water is allowed to settle. The medical center in the community has 25 years of records and diarrhea is the most common disease. The records show that all the adults have amebas and some have worms in their digestive system. This is suspected as being caused by drinking unsafe water. The health records showed *Entamoeba, histolyticas, Ascaris lumbricoides (eggs),* and some *Giardia.*

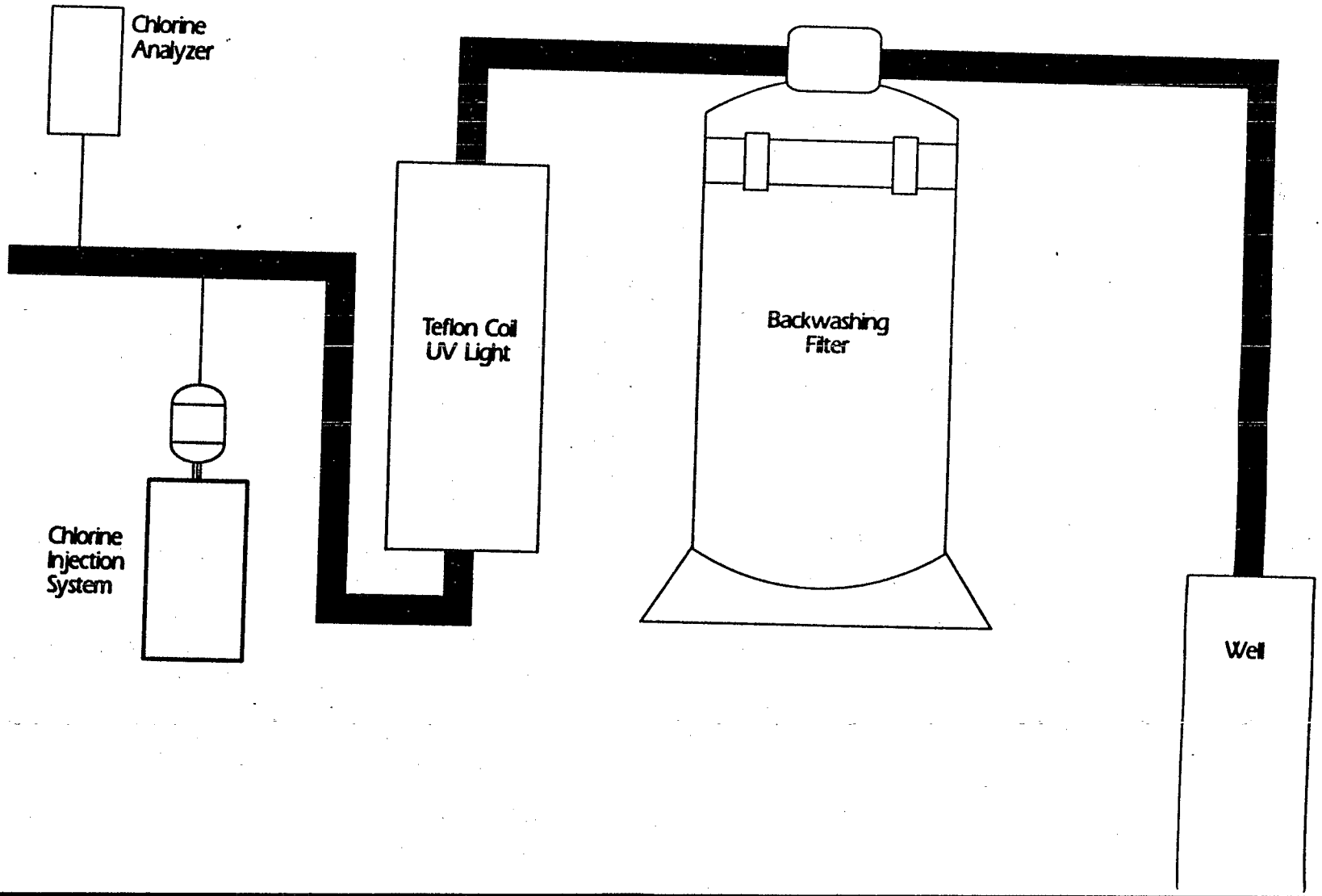
Before treatment is installed, source protection at the spring will be completed consisting of completely containing the spring in a concrete structure with a removable or hinged lid. Treatment is expected to consist of an iodinated resin unit at the Health Clinic where residents can obtain treated water.

## MEXICO

Demonstrations of drinking water treatment technologies in Mexico are being funded under an interagency agreement between the U.S.EPA and the U.S. Department of Agriculture Foreign Agricultural Service (U.S.D.A.). After a visit to Mexico in June, 1995, three demonstration sites were identified where there is a need and a willingness to participate in the project. A solicitation for request for proposals generated thirteen proposals. These proposals have been reviewed and final selections were not completed at the time of this writing. Below is a description of the demonstration sites.

- Jilotepec - This water system serves a population of approximately 3,500 people with a flow of approximately 120 gpm. The town is served by two separate distribution systems; a) surface water which is approximately 40% and b) spring water which is approximately 60% of the water supply in town.

# Figure 2. Monteoscuro Treatment System



Jilotepec is in a valley and the water that is supplied comes from the mountains overlooking Jilotepec. The surface water that would be treated in this project flows from a small impoundment area to a tank that is several hundred feet higher in elevation than the town. The current treatment is chlorination only. This particular site provides a challenge to logistics of getting treatment package technology up the side of a mountain as there is not a roadway compatible for vehicular traffic. The surface water is very susceptible to changing conditions during the raining season and appeared to be moderately turbid during the initial site visit. Water is chlorinated as it enters a tank and then is provided to the town via a gravity feed system.

- Ixhuaçán de los Reyes - The community of Ixhuacán de los Reyes is supplied with water from Rio San Jose. This community of approximately 2,600 people has a water demand of approximately 85 gpm. Water from the river which is located higher in elevation than Ixhuacán, flows by pipeline down the side of the mountain and enters a rectangular presedimentation tank that is split into two chambers which would allow operation of either side individually or parallel. From this first presedimentation tank the water then flows into a second rectangular sedimentation basin and flows by gravity several hundred yards down the side of the mountain into a typical stone storage tank. No chemical treatment occurs until chlorine is added at this point and the water then flows from the outlet of the stone tank to the city of Ixhuacán.

- Francisca I Madero Public Elementary School - The Francisca I Madero Public Elementary School is located in a small suburb near Cordoba and serves approximately 300 children who attend the school daily. The water supply for the school is a hand dug well, approximately 30 feet deep, five feet in diameter and has a stone or brick interior wall. It is covered but not sealed to prevent foreign material from entering the well. This water then is pumped from the well to rooftop cisterns which is open to airborne contamination. This provided pressure for the system inside the school. Currently, the children are advised to bring water or beverages from their homes.

The health care system in Mexico provides clinics that serve several communities from a single clinic. All of the sites described above, with the exception of the elementary school, have good health records that indicate that gastrointestinal disease is prominent. In speaking with doctors and nurses at several clinics, drinking water is suspected to be a primary cause of the gastrointestinal diseases. Cholera is also a serious concern of being transmitted by the drinking water in these communities. The clinics posted warning signs and sets of instructions to educate members of each community on proper sanitary practices in the prevention and spread of this disease.

CHINA

This on-site demonstration program will mainly focus on U.S. membrane drinking water treatment technologies as a reliable and effective solution for various drinking water problems widespread in northern China. This project will be completed under an interagency agreement between the U.S.EPA and the U.S.D.A.

Partnering with the U.S.D.A. will accelerate the diffusion of innovative technologies because contact has been limited for years between China and the United States plus the Chinese governmental structure is very complicated and only partnerships between government agencies that have worked within the Chinese organizational structure and private companies will be accepted. A visit to China for selecting demonstration sites was done the first two weeks of February 1996.

The goal of this project is to demonstrate cost-effective drinking water treatment technology for the removal of industrial organics, agricultural pesticides, heavy metals, fluoride, and pathogenic contaminants from drinking water in northern China. Up to three sites may be selected depending on raw water characteristics.

The proposed on-site demonstrations will be performed in collaboration with the Institute of Environmental Geology under the Ministry of Geology and Natural Resources, The People's Republic of China. It is initially agreed that when these on-site demonstration proposals are approved, the Institute of Environmental Geology will seek Chinese grants to perform the necessary analytical work either in their own laboratories or local universities, such as, the Geological Sciences graduate school. In addition, with the small community demonstrations, an epidemiological study comparing the health rates of the case study site vs. nearby communities with untreated water will be conducted by local graduate students.

One demonstration project is expected to take place in Zibo City in the Shandong Province to demonstrate the removal of industrial organics. Another demonstration may include the City of Chifeng where the raw water is contaminated with fluoride, agricultural chemicals, and industrial wastes.

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